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Heating · Piping and Air Conditioning

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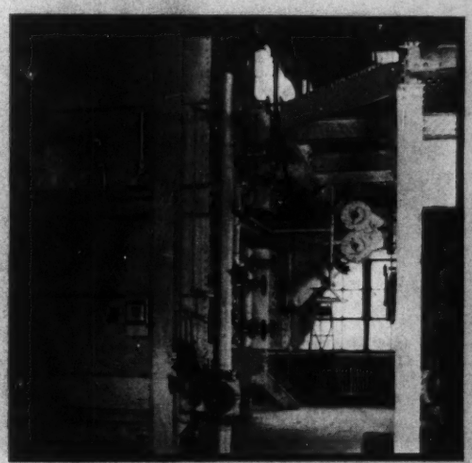
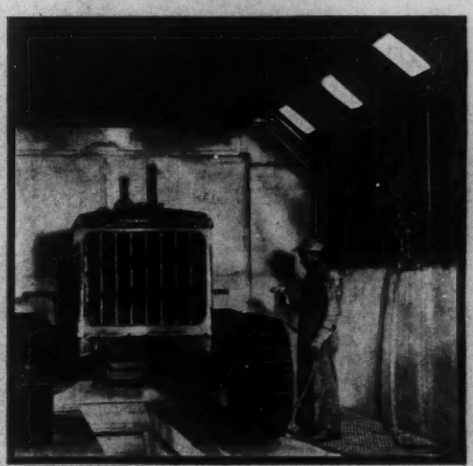
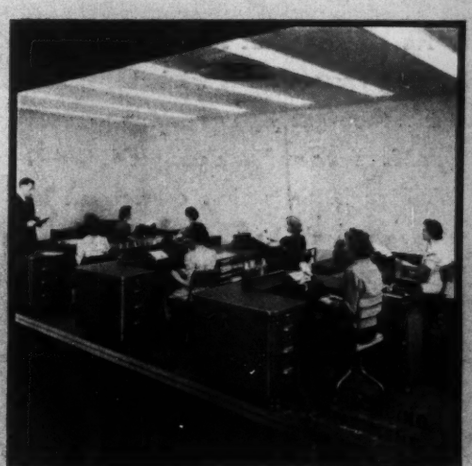


HEATING station supplying steam and power requirements of several properties improves economy and service by installing gas engine driven generator. See p. 643



PIPING for paint circulating systems for modern industrial finishing is described in an article on p. 665. The method offers a number of worthwhile advantages



AIR CONDITIONED windowless office space for a moderate size manufacturer is described in an article starting on p. 647. Office efficiency improved

NATIONAL DEFENSE requires vocational training. John Howatt writes on engineering preparation in "Open for Discussion," p. 656

Page 671
Journal Section
the American
y of Heating and
ating Engineers

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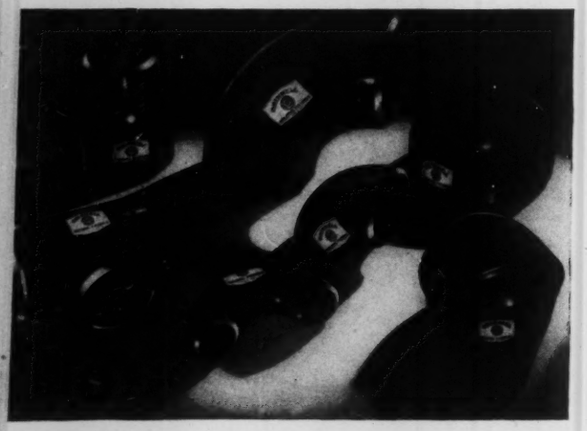

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ERASE THIS COST!

NASH VAPOR TURBINE HEATING PUMPS REQUIRE NO ELECTRIC CURRENT.

The Nash Vapor Turbine Return Line Vacuum Heating Pump requires no electric current, eliminating the one biggest heating pump operating expense item. The motive power is a special turbine operating on steam direct from the heating system. Steam used is returned to the system for heating, with little loss.

But the important saving promoted by the Nash Vapor Turbine is in the system itself, for this is the only heating pump that can operate continuously with economy. This uniform circulation means a big saving in steam.

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THE EDITOR'S PAGES

WINDOWLESS BUILDINGS

While windowless buildings are not new—H. C. Murphy reports on p. 657 that they were built in London in the 1600's because of a window tax—the increased use of air conditioning in recent years, development of glass block for building construction, and now the question of wartime black-outs for defense against bombing have all promoted interest in them. Air conditioning is of course the most important of these factors, for without air conditioning windowless construction is hardly feasible.

Walter Fleisher covered the importance of protecting defense industries from air attack in an editorial in the July, 1940, HPAC, and extends his thoughts on the subject on p. 646 this month. There is also an article this month (p. 647) on windowless, air conditioned office space for a medium size manufacturer; particular attention was given in the interior decoration of this building to counteract any detrimental psychological factor that might result from the lack of windows, for this question frequently comes up for consideration.

The air conditioning of most of the modern, windowless industrial buildings has been described in articles published in HEATING, PIPING AND AIR CONDITIONING over the past several years. For those interested in the subject, data on the Johnson Wax building, Racine, Wis., will be found in January, 1937, April, 1938 and November, 1939; the Simonds Saw and Steel plant in November, 1938, and December, 1939 (p. 730); the National Aluminate building in February, 1937; Hershey Chocolate's office building in December, 1936; Detroit Edison's glass block building in October, 1937, and April, 1938; the Allison aircraft engine plant in March, 1940; and a windowless printing plant in December, 1938 (p. 783).

As with most subjects which are "alive," the trend is not by any means entirely to windowless construction. Glass is widely used in modern architecture, and new developments have been made in reducing solar heat gain through windows to cut down summer cooling loads. At least one architect, who uses large glass surfaces in his designs, is endeavoring to determine just how much of the winter heating load can be taken care of by heat from the sun, for he has noted encouraging results in some cases. His idea is to so design and orient the structure as to receive the maximum solar heat in winter and the minimum in summer.

HANLEY ELECTED ASME PRESIDENT

William A. Hanley, director of Eli Lilly & Co. and head of its engineering division, has been elected by letter ballot of the 15,000 members of the American Society of Mechanical Engineers to be president of the 61 year old engineering organization during 1941. Mr. Hanley is a member of HPAC's board of consulting and contributing editors and the author of a number of articles which have been published in our pages.

Among the vice-presidents elected at the same time was Edwin B. Ricketts, mechanical engineer with Consolidated Edison Co. of New York. Among the managers of the society elected to serve on the council for three year terms are Huber O. Croft, head of the department of mechanical engineering at the University of Iowa, and George E. Hulse, chief engineer, Safety Car Heating and Lighting Co. New officers will be installed during the 61st annual meeting of the ASME at the Hotel Astor, New York, December 2-6.

DISCUSS PLANS FOR INDUSTRY EXHIBIT

Plans for the "all-industry" refrigeration and air conditioning exhibition were made and details for attendance promotion work completed at the fall meeting of the Refrigeration Equipment Manufacturers Association held at French Lick, Ind., last month. The exhibition is scheduled for January 13-16 at the Stevens Hotel, Chicago.

M. W. Knight, sales manager of Peerless of America, and chairman of the exhibition committee, reported that 160 exhibit spaces had been taken—exactly the total number sold for the 1940 exhibit held last January.

AVERY ENGINEERING ENLARGES FACILITIES

Lester T. Avery, author of a number of articles which have appeared in these pages, has announced that the Avery Engineering Co., of which he is president, has recently leased space at 1906 Euclid, Cleveland, in order to enlarge its facilities for handling air conditioning work and commercial refrigeration. The space includes a ground floor store of 3000 sq ft and an equal area in the basement.

Part of the space will be devoted to displaying "Koolshade" sun screen in various mountings; this is a flat wire screen designed to block out sun heat and sunlight and is manufactured by the Ingersoll Steel & Disc Div. of Borg-Warner Corp. The display room will also include air conditioning and commercial refrigeration equipment; Avery Engineering is distributor for Ohio for the Carbondale Div. of Worthington Pump & Machinery Corp.

DIRECTING 2,000,000 HORSEPOWER

What load dispatchers do about the weather was one of the topics discussed by Paul B. Juhnke, chief load dispatcher of the Commonwealth Edison Co., Chicago, in a paper presented at the recent Midwest Power Conference, according to the "Edison Round Table."

Darkness, resulting from smoke clouds which due to absence of wind remain stationary for considerable periods, will vary the load in a metropolitan center as much as 15 per cent from that of a light day.

The next most important influence on load is the temperature. Between 45 and 75 deg the temperature has practically no influence. Above that range, air conditioning will increase the total load by as much as 4 per cent, and below 40 deg will increase the heating load by as much as 6 per cent, especially when the traction system cars are using electric heat. Temperature changes are generally gradual and easy to follow, he said.

NAVY CLARIFIES DEFENSE CONTRACTS

Instructions in regard to subcontracts under cost-plus-a-fixed-fee contracts have been recently issued by the chief of the bureau of yards and docks of the navy department. It is pointed out in the instructions that it is desired that the distinction between subcontracts and material purchases be kept in mind in order that the making of subcontracts will be confined to cases which involve the employment on the site of supervision and labor in excess of what is ordinarily required to fix or install the material in place. For instance, where structural steel is purchased for a building and there is involved the ordinary erection of same, the operation would be considered to be a material purchase. Also, where a boiler, electric generator or similar apparatus is to be installed as an individual item the material purchase procedure is proper.

A material purchase must necessarily be on a lump sum basis, according to the

instructions, and the lump sum must include any profit for the seller of the material, the profit for the general contractor being included in the general contract fee.

With reference to subcontracts, as distinguished from material purchases, the procedure for their negotiation should follow as closely as practicable the procedure preliminary to the execution of public works contracts, either of the lump sum, the unit price or cost-plus-a-fixed-fee type, it was stated. In the case of a subcontract of the cost-plus-a-fixed-fee type the procedure preliminary to awarding it should be as near as practicable to the procedure that was followed in awarding the general contract, and negotiations should be had with at least three reputable and qualified contracting concerns. Subcontracts should provide for payment by the general contractor to the subcontractor of the actual net cost of the labor and materials involved plus a lump sum for the services of the subcontractor's organization, which lump sum should include any profit to the subcontractor, the amount of which would not be stated separately as profit or a fee.

If the execution of a subcontract materially changes the scope of the work to be done by the general contractor from that originally contemplated, a change in the amount of the fee to be paid to the general contractor would be in order.

These instructions were issued to supplement or clarify a "multiple letter" dated July 20, 1940, on the administration of fee contracts. In the July 20 letter it was stated that the bureau of yards and docks desires to avoid doing business with the purely broker type of contractor, but this does not imply that subcontracts will not be permitted as each contract must be considered on its own merits. In many instances, it will be found that a subcontract with a specialist—such, for example, as a heating and ventilating contractor—is to the advantage of the government either in time or cost, or both. Whether or not a subcontract shall be permitted shall be decided by a consideration of whether or not it is to the advantage of the government to do the work by subcontract.

INDUSTRY ORGANIZES FOR DEFENSE

A unique plan to coördinate facilities of 248 manufacturing plants in York, Pa., and vicinity for government defense work has been developed by William S. Shipley, chairman of the board, York Ice Machinery Corp. Under the plan, upwards of 20 million dollars in defense orders have been split up among local industries without interference with regular commercial orders. The plan includes a "pooling" of all manufacturing machinery in York county under the supervision of the York manufacturers' association. At association headquarters an information file of available machinery enables government officials to determine if the plants of the area can handle a contract for them.

Assurance that all employees called for military training will be restored to former positions or to positions of like seniority, status and pay "unless the company's circumstances have so changed as to make it impossible or unreasonable to do so" was given last month by J. I. Lyle, president of Carrier Corp. In a general management bulletin Mr. Lyle also announced that arrangements had been made to permit those serving to continue their group life insurance policies if desired.

General Electric Co. employees who are called for military service or who voluntarily enlist for the 12 months' training period will receive a full month's pay and be granted a year's leave of absence, according to Charles E. Wilson, president of the company, and on expiration of military service will be restored to their former positions or to positions of like seniority, status and pay "unless circumstances make it impossible or unreasonable to do so."

Orders received by General Electric during the three months ended September 30 amounted to $185,156,837, which represented an increase of 133 per cent over the same period last year and was the largest amount of new business ever received by the company in any three months' period. Largely as a result of the national defense program, orders for the United States government have accounted for slightly more than one-fourth of the total business obtained so far this year. Orders from regular commercial sources during the first nine months of the year increased 31 per cent over the same period a year ago.

NEW RESPONSIBILITIES

Anker Winther has been made assistant general sales manager of York Ice Machinery Corp., according to an announcement by John R. Hertzler, general sales manager. A graduate of Stevens Institute of Technology in 1928, he entered the York student course on leaving college.

Mr. Winther was the author of an article published in our January, 1936, issue which described the air conditioning of the 15 story American building in Cincinnati, Ohio.

* * *

The appointment of A. D. Lynch as personnel director of Young Radiator Co. was announced recently by F. M. Young, president. Mr. Lynch was formerly personnel director of J. I. Case Co.

Richard P. Dodds, advertising and sales promotion manager of the Truscon Steel Co., was elected president of the National Industrial Advertisers Association at its recent annual conference held in Detroit. Among the vice-presidents elected was Terry Mitchell of the Frick Co.

* * *

C. N. Rink has been appointed manager of the air conditioning coil division of McQuay, Inc. For the past three years Mr. Rink has been manager of the Murray Co., Atlanta contractor and distributor of heating, ventilating and air conditioning equipment.

* * *

The Ilg Electric Ventilating Co., Chicago, announced recently the appointment of P. D. Briggs as general sales manager. Mr. Briggs, who came to Ilg in 1917, will continue to reside at New York and to perform his duties as vice-president and eastern manager.

* * *

Earl Marr has been appointed general sales manager of the Airtemp Div., Chrysler Corp., according to D. W. Russell, president.

MAN POWER FOR DEFENSE

H. C. Burgess, president of the Chicago Men Over Forty Club, pointed out in a statement last month that America's best line of defense is her industries and that these must be kept working at full manpower and their staffs must be kept filled with well-trained and experienced men.

The club, a non-profit coöperative movement, seeks to provide industry and business with executives in all lines, as do 30 other similar organizations in the United States serving the larger areas. There are no fees or charges to employee or employer.

MANY EXHIBITS FOR POWER SHOW

The 14th national exposition of power and mechanical engineering—the power show—scheduled to be held at the Grand Central Palace, New York, December 2-7, will be the largest exposition of its kind since 1930, according to an announcement by Charles F. Roth, president of the International Exposition Co. and manager of the show.

Among the advance reservations for space are well over 100 exhibits planned directly to cover the fields of heating, air conditioning, ventilation and refrigeration. There will also be numerous exhibits of piping, pipe fittings, valves, pipe cutting and pipe cleaning appliances, pipe bending machinery and tools, etc.

Heating · Piping and Air Conditioning

Vol. 12, No. 11 • November, 1940

Gas Engine Driven Generator Improves Operation at Franklin Heating Station

Engine and Steam Turbine Units Working Together Promote Efficiency of Heat and Power Plant . . . By Neil D. Adams*

SUMMARY

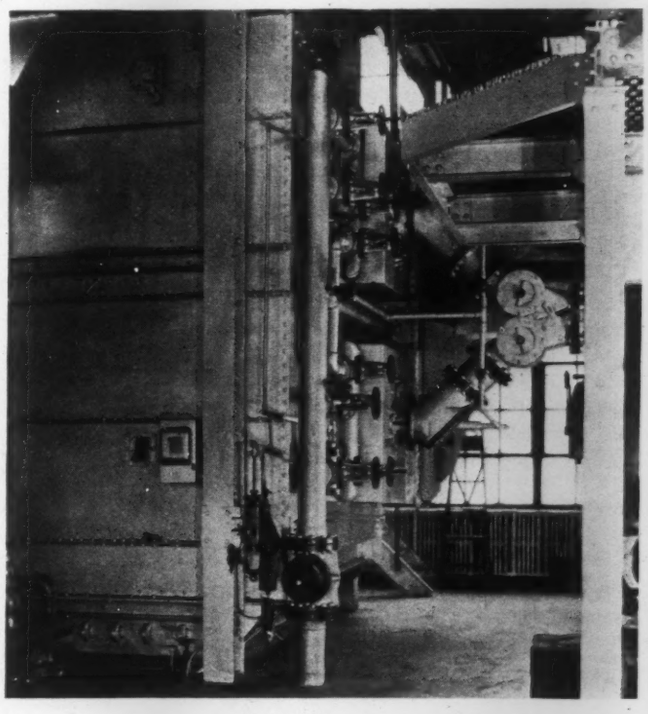
When natural gas by pipe line from Texas became available at Rochester, Minn., where the Franklin Heating Station is situated, a change-over from pulverized coal to gas was made, as difficulty had been experienced in maintaining efficiency at low boiler ratings and with fly ash. Steam demands on the station—which serves the Kahler Corp. and Mayo properties with heat and power—are fairly steady in the winter, but in summer the steam demand is regulated mainly by the electrical load—a daytime load—and under these conditions with the pulverized fuel the 24 hr efficiency of the boiler unit was not more than 70 per cent. Conversion to gas was simple, as it was possible to install ring type burners in the refractory between the pulverized coal burner and the furnace. To obtain the industrial gas rate, it is necessary to be able to change from gas to the standby fuel on 15 min notice; with the combination of gas and pulverized coal, it is possible to do this, or to burn coal and gas at the same time . . . . . The next step in the program discussed here by Mr. Adams was the installation of a gas engine driven electrical generator unit. When the peak electrical demand became too great to be carried safely on one of the two existing steam turbine driven generators, the engine driven unit was installed, the engine being designed for conversion to oil operation by the installation of new pistons and a fuel injection system in case of failure of the gas supply (although the possibility of this is remote). Operating tests have indicated that the gas engine generator leads to worthwhile economies in gas and water consumption, has improved voltage regulation (constant voltage is essential for x-ray service), and it also provides a valuable emergency or standby unit for service in winter

THE Franklin Heating Station, completed in 1928, supplies the steam and power requirements of the Mayo Clinic and other properties in Rochester, Minn. As described in the October, 1929, HPAC, the station was originally operated on coal from southern Illinois mines. In January, 1932, it was possible to contract for natural gas supplied by a pipe line from Amarillo, Tex., to Minneapolis, Minn., and serving towns and villages within an area 100 miles in width. Rochester is served by a 9 in., 40 mile branch line from Owatonna, Minn., and the station is supplied by an industrial line at 35 lb pressure. Gas delivered to the station averages 1000 Btu per cu ft.

In 1930 a new boiler had been installed at the station for burning pulverized coal. This boiler was equipped with a tube type air preheater and a complete water wall furnace, with pulverizers of the combined hammer and pin type. Boiler capacity is 70,000 lb per hr of steam at 300 lb pressure and 600 F total temperature.

This boiler was operated for two years on pulverized coal, with the following results: From 150 per cent of rating and up the combustion was good, resulting in an over-all boiler efficiency of 80 to 82 per cent. However,

When natural gas became available, the pulverized coal burning boiler was converted to gas firing by installing ring type gas burners in the refractory between the coal burner and the furnace. With the combination burner arrangement it is possible to switch from gas to coal in a few minutes or if desired it is possible to burn gas and pulverized coal at the same time



*Superintendent, Franklin Heating Station.

Copyright, 1940, by Neil D. Adams.

when the load dropped to 100 per cent of rating or below, the furnace efficiency dropped until it was barely possible to maintain combustion at 50 per cent of rating. This was caused by the large amount of radiant absorption surface exposed to the burners, resulting in too low a furnace temperature at low rating.

Steam demands on the station are fairly steady during the four heavy heating months in the winter and during this period good efficiencies were maintained. During the other eight months—particularly the four summer months, when there is no need of heating—the steam demand is regulated mainly by the electrical load, which is a daytime load. Operating under these conditions, the 24 hr efficiency of the boiler unit was not more than 70 per cent.

It was also discovered that about 80 per cent of the ash was going up the chimney. Some was carried away by prevailing winds and I suppose is still floating around in the stratosphere. About 90 per cent of the ash which left the chimney, however, caused complaints. On a few days when there was no wind and the atmosphere was heavy with a slight mist, it was necessary to flush the sidewalks surrounding the plant. This condition was becoming unbearable and the problem of installing dust collectors and a removal system was imminent when it was learned that gas would be available for use.

Change Over to Gas

The conversion from pulverized coal to natural gas was simple in the new boiler, where it was possible to install ring type gas burners in the refractory between the pulverized coal burner and the furnace. The gas and air supply are both regulated by the automatic combustion control system; thus, the correct mixture is maintained at all ratings and it is possible to secure 80 per cent efficiency throughout the 24 hr day even with a very low rating on the night load in the summer months.

For us to obtain the industrial gas rate it is necessary to provide at all times an emergency fuel standby which can be started and can be ready to carry a full load on 15 min notice; this is to protect domestic users in case of pipe line failures or in times of excessive heating loads, when the outside temperature is 0 F. With the combination burner it is possible to change from gas to pulverized coal in a few minutes or to burn coal and gas at the same time.

Some of the advantages due to the use of natural gas at the Franklin Heating Station have been:

1) Better over-all efficiency due to higher efficiency at low ratings and to clean heat transfer surfaces.

2) Elimination of soot blowing, resulting in saving of steam formerly used three times daily for that purpose.

3) Lower furnace maintenance.

4) Elimination of maintenance and power costs for coal handling and burning equipment.

5) Elimination of dust both inside and outside the plant.

6) Elimination of labor formerly required for attending coal handling and ash removal.

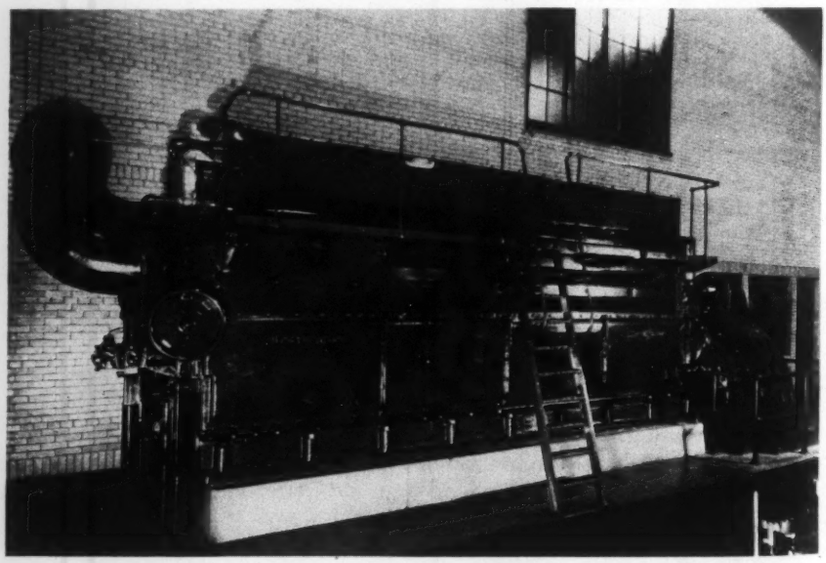
Gas Engine Driven Generator

In the summer of 1938 the peak electrical demand became too great to be carried safely with the use of one of the two steam turbine generator units with which the plant was equipped. Therefore, it was necessary, in the daytime, to operate two units condensing; this resulted in low efficiency and excessive use of condensing water. Also, there remained no reserve unit in case of mechanical trouble. Because the station serves partly a group of hospitals and because the first requirement in hospital work is continuity of service, units of equipment were duplicated throughout the system. This duplication included boilers, generators, electric cables, transformers and so on. This resulted in a low load factor with high fixed charges, but such duplication is essential when surgical operating rooms are in continuous use or are held ready for emergency service.

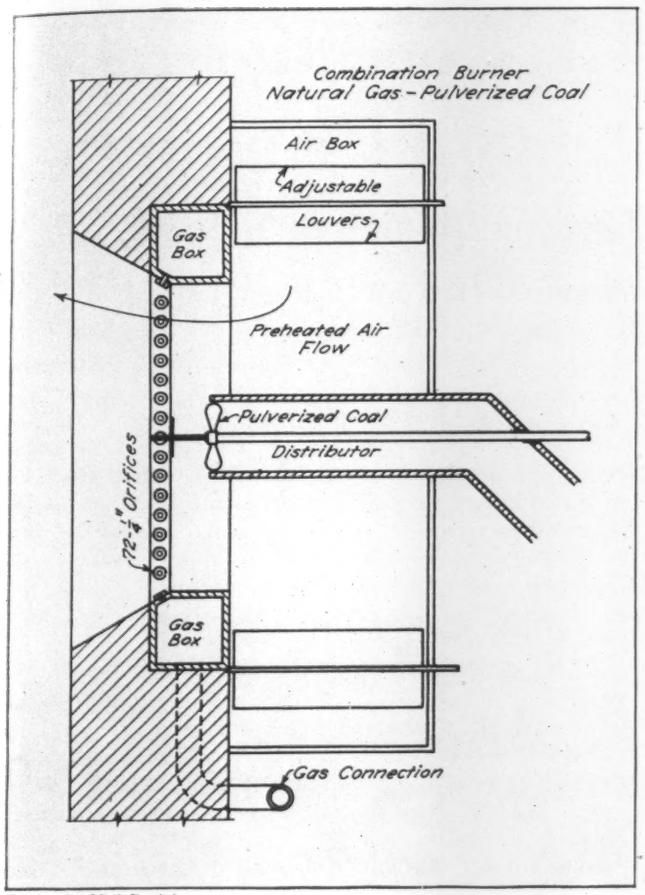
Following a study of daily electrical demand during the summer months, a gas engine generator unit was installed in June, 1939.

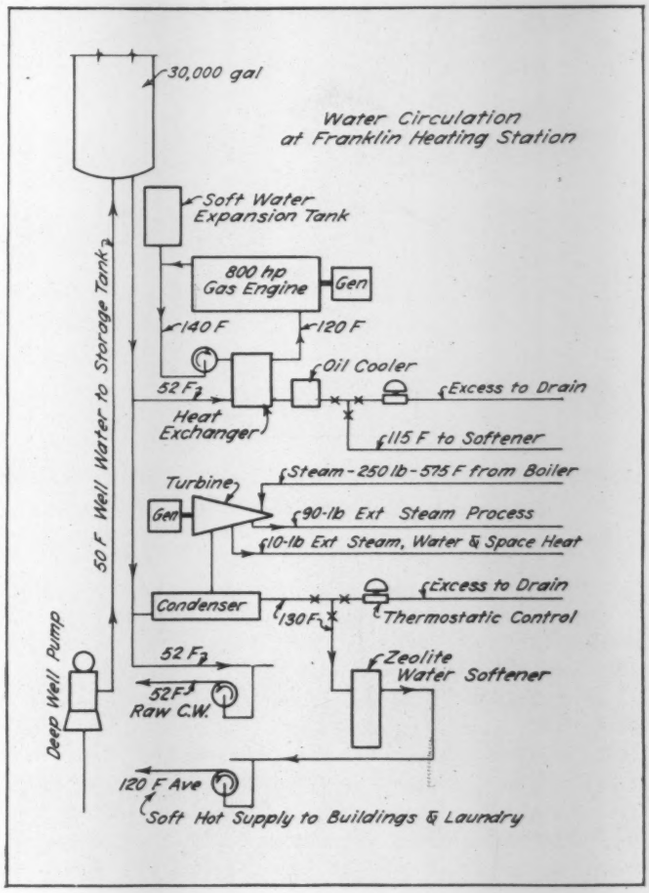
The 800 hp, 360 rpm engine is connected to a 600 kw, 760 kva air cooled generator. The engine is designed for conversion to oil operation by the installation of new pistons and a fuel injection system; this conversion can be made in 48 hr in case of failure of the gas supply. The possibility of such failure is remote, however, as the pipe line company is duplicating its equipment and lines.

The cooling system of the engine is what is commonly termed a "closed system." Softened (zeolite) water is continuously circulated from the engine through heat interchangers. Water at 50 F from deep wells is circulated through the exchanger tubes, from which it flows at 115 F to the water softeners and from there to the pumps which supply the buildings—one of which is a laundry—with domestic hot soft water. Booster heaters in the separate buildings raise the temperature of the water to that required for any particular process; the booster heaters are supplied with steam at 10 lb pressure extracted from the steam turbine.



When the peak electrical demand on the Franklin Heating Station became too great to be carried safely with the use of one of the two steam turbine generator units, this gas engine generator unit was installed. The engine is designed for conversion to oil operation





Design by Neil D. Adams

Performance and Operation Tests

On September 23, 1939, a performance test was run with results which were as follows: ½ load, 280 kwhr, 16.5 cu ft per kwhr; ¾ load, 420 kwhr, 14.2 cu ft per kwhr; full load, 560 kwhr, 13 cu ft per kwhr.

Based on operation at full load, the unit fuel cost per kwhr with gas at 18.5c per 1000 cu ft was ¼c per kwhr.

Since installation of the engine was not completed until late in the summer of 1939, since it was primarily designed for summer peak operation and since it was not intended to be used in cold weather (except in emergency) operating tests were deferred until June, 1940.

Two days were chosen when the general load demands on the plant would be as nearly alike as possible; i. e., Tuesday and Wednesday of any week during the three summer months. On Monday, the load demands from the clinic are variable but usually heavy, and from Thursday on there is a lessening of demand, which also is variable.

On Tuesday, June 4, the engine unit was put on the line, running together with one steam turbine generator unit, at 7:30 a. m. and was run until 5:30 p. m. On Wednesday, June 5, the load was carried on one steam turbine generator (although the generator operated on an overload during the morning peak). The day was cool, which helped during the morning peak load, and overheating was not encountered. Better efficiency was obtained than could possibly have been had by running both 1000 kw machines during the time of peak load.

Complete and accurate records were made during the runs of both days and included total gas consumed, steam generated, steam flow to turbine, electricity generated, and water used (estimated from steam flow to turbine) for condensing and engine cooling:

1) The total gas consumed with both machines on the line showed a saving of 3.3 cu ft per kwhr. Calculations are as follows: June 4: 682,000 cu ft ÷ 15,010 kwhr = 45.5 cu ft per kwhr; June 5, 708,000 cu ft ÷ 14,520 kwhr = 48.8 cu ft per kwhr. These figures represent not only the kwhr produced but also heat sent out to the buildings, including the laundry, in the form of steam for process work. This amount was assumed to be approximately the same on both days.

2) Sixty-seven thousand lb less steam was required on June 4, when the gas engine was running, than on June 5. All of this steam was above process requirements and was condensed on June 5, requiring approximately 137,000 gal of condensing water to be pumped. The engine cooling requirement during the 10 hr on June 4 was 37,000 gal; thus there was a saving of 100,000 gal of water.

3) Improved voltage regulation was secured with both gas engine and steam turbine units on the line. Constant voltage is essential during the daytime for x-ray service. With the turbo-generator operating at peak loads the voltage was not constant, due to the inability of the turbine to handle electrical bumps and maintain constant speed. With the gas engine generator carrying half of the load, the turbo-generator unit could take the line swings without reduction of speed. Erratic swings on both gas and boiler steam charts were eliminated on June 4. when the gas engine was operating.

4) The gas engine unit, which is entirely independent of the steam system, serves as an emergency unit during the winter, in case of failure of a boiler or a steam line.

Reclamation of additional heat is planned for the future by installation of a waste heat boiler in the engine exhaust line.

Industrial Plant Air Conditioning and the National Defense Program

Walter L. Fleisher* Advocates Air Conditioning of Existing Factories as Well as Our New Windowless Plants

A SHORT time ago I wrote on the necessity of air conditioning for industries, particularly for those factories where—with foresight for possible aerial attacks—no windows were utilized in their construction. At the same time I advocated methods of producing results that would preclude the possibilities of shutdowns—such as dividing the air conditioning systems into smaller units so that in case of failure of one or more of the units the balance could keep conditions sufficiently favorable to carry on and produce the required goods. Diversified methods of changing the conditions—such as chemical or colloidal absorption or adsorption, diesel drives, well water or inside cooling towers, supplementary power mains—were all advocated without undue emphasis on any one particular method. I pleaded only that the expense of procuring these results—that is, from $1.00 to $1.50 per sq ft of floor space—should not be a deterrent factor. Of course, I advocate the cheapest method that will give the desired result.

Now in the course of a very few weeks (and probably due to the intensive bombing of England and Germany) the idea of protecting our new plants by eliminating windows or even by building them partially underground, has assumed such momentum that I am hastening to follow up my previous advocacy of this type of air conditioned plant with a few words of advice and warning.

I realize that a great number of our new plants are for the manufacture of precision machinery. When one is providing for that kind of work, exact conditions lend themselves to better work and greater precision. Seventy-five degrees dry bulb and 50 per cent relative humidity, maintained at all times, will allow men and goods to work together for a nearly perfect product, with a contented body. When one considers that this condition means a saturation temperature of 55 deg and an entering dew point of 52 deg, it can be readily understood (at least, by the engineer) that well water alone will not usually produce these conditions, but that dehydration or refrigeration is essential for this result. In our modern theaters, 80 deg and 50 per cent relative humidity—a dew point of 60 deg—is considered amply comfortable. In the investigations of the American Society of Heating and Ventilating Engineers into the requirements of air conditioning in industry, it was determined that no physiological changes took place in human beings at normal effort before a condition of 78 deg effective temperature was reached. It may be that when we design air conditioning for 75 deg dry bulb and 50 per cent, or an effective temperature of 70 deg, we are going further than necessary and establishing a condition that we will regret in the future.

We consider an emergency in war or in times of depression; we create social reforms and emergency legislation to combat these conditions, but they become part of our lives and our social structures, and we never without violence retrace our steps. One political party enacts a social reform; when the other party comes to power, it adopts it.

Much the same reasoning applies to the matter of air conditioning in industry. Nothing is too good for our new plants. We justify this by saying that having built windowless plants or subterranean plants, we must condition them; and I say, wholeheartedly; that yes, we must. But we must also think of this fact: The new plants, without windows, will be so much more comfortable and efficient than existing plants with windows, monitors and so on, that no one will want to work in the old plants unless similar relief is provided.

In my article, published in the July HEATING, PIPING AND AIR CONDITIONING, I advocated also that new plants be situated where nature would provide a good deal of the sources of proper air conditioning. A dry climate means a low wet bulb, and much comfort can be derived from utilizing that condition through evaporation. Well water at 52 to 53 deg will readily provide a 78 deg effective temperature, if enough well water is available. Our rayon industry, which requires vast quantities of wash water and regulated air conditions, builds its factories where cheap and cold water is available, and its progress is one of the great success stories of the century.

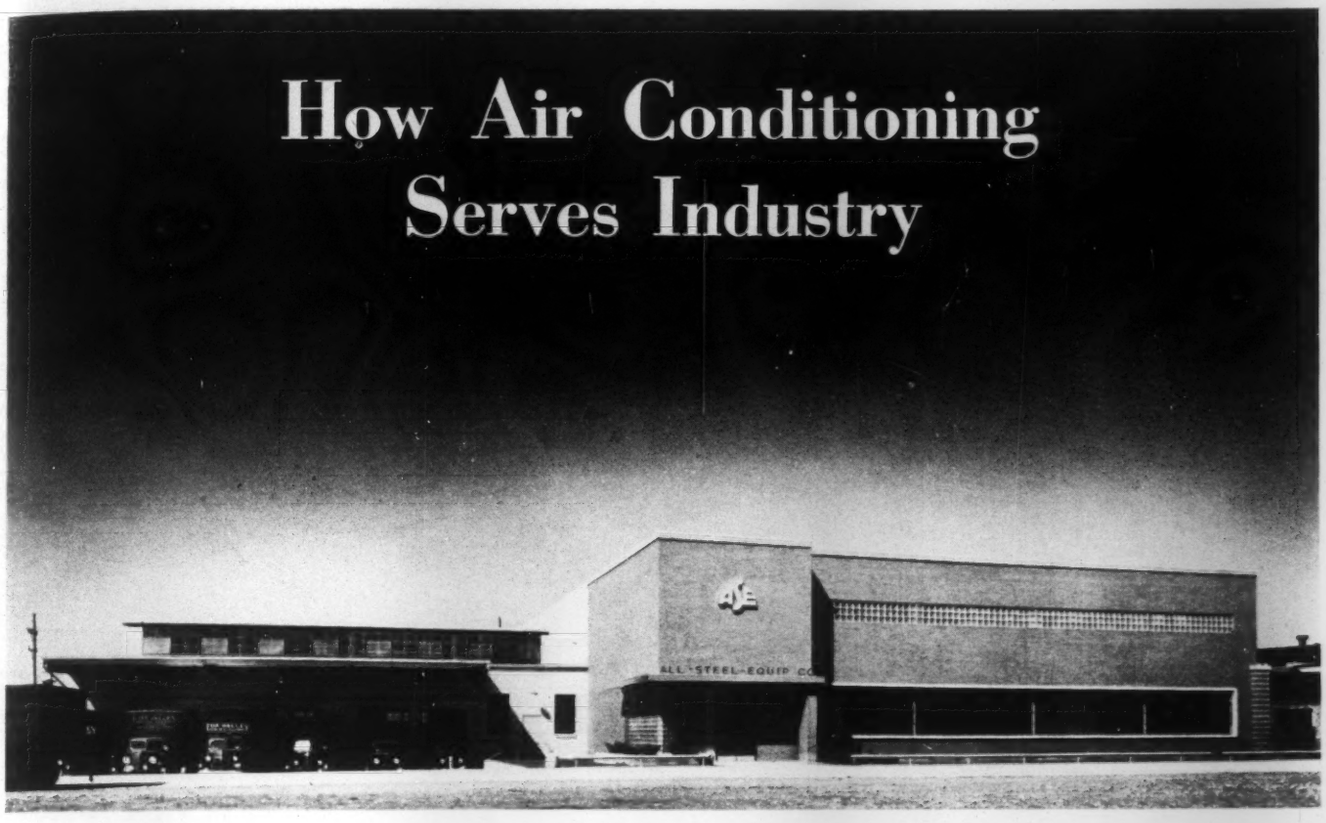
In our new expanding war industries let us be just as wise and see our present through our future glasses.

SUMMARY

The idea of protecting our new plants from aerial attack by eliminating windows or by building them underground has assumed much momentum in the past few weeks due to the bombing of English and German cities and industries. In the July HPAC, Mr. Fleisher advocated windowless construction, and recommended methods of precluding shutdowns — such as dividing air conditioning systems into smaller units so that failure of one or more would still allow favorable atmospheric conditions to be maintained. . . . . Mr. Fleisher believes that equally careful consideration should be given to air conditioning our existing factories, as well as the new windowless plants where air conditioning is essential. So that air conditioning in industry may have widespread application, such factors as the proper type of equipment, suitable temperatures and humidities, availability of well water of the proper temperature, and location of plants in areas where the climate is favorable should be studied

*Consulting and Advisory Engineer. Member of HPAC's Board of Consulting and Contributing Editors. First Vice-president, American Society of Heating and Ventilating Engineers.

How Air Conditioning Serves Industry



All-Steel-Equip Co.'s New Headquarters

JUST completed adjacent to its main plant in Aurora, Ill., are the new general offices of All-Steel-Equip Co., Inc., manufacturer of steel office equipment and other products. This "controlled conditions" building is of particular interest in that it is a practical example of a modern, windowless, air conditioned building for a moderate size manufacturer. Too often, articles are published on buildings which are outstanding but which few owners would have need for; hundreds of plants, however, throughout the country need now—or will need—a building like this one.

The company's office force, sales personnel and executive staff have been transferred to the new headquarters building, which comprises 16,000 sq ft of modern air conditioned office space, lighted entirely by fluorescent tubes in concealed troughs that provide continuous bands of light across the entire area. Designed and built by the Austin Co., pioneers in the development of windowless buildings, the offices occupy the second floor of a 43,400 sq ft addition. In addition to the general office, there are 16 private offices, each of the latter having its own individual thermostatic temperature control for both winter and summer. Modern warehousing, receiving and shipping facilities are also provided by the building, thus liberating a substantial area in the existing plant for manufacturing operations to increase production capacity. The receiving and shipping areas are heated by projection type unit heaters.

SUMMARY

Typical of the needs of many manufacturing plants throughout the country were those of the All-Steel-Equip Co., Inc., manufacturer of office equipment, storage lockers, electrical wiring boxes, industrial equipment, etc. Increased production facilities were needed and an efficiently designed, air conditioned office was required. . . . . The problem was met by the new building at Aurora, Ill., shown above, adjacent to the existing plant. Modern warehousing, receiving and shipping facilities are provided on the first floor and at the left, releasing a substantial area in the plant for production. The windowless, air conditioned second floor provides fluorescently lighted, sound treated office space which—because of air conditioning — could be designed strictly from the standpoint of office efficiency. The glass block band is for architectural effect and auxiliary lighting

Air Conditioning Considered Essential

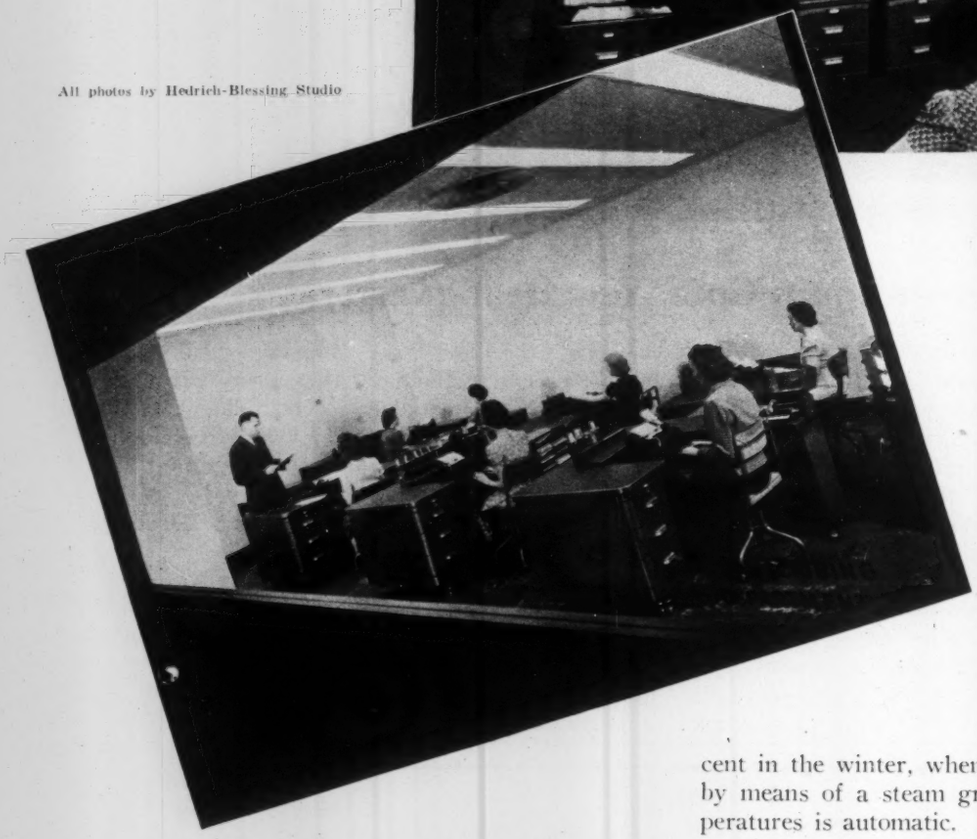
Air conditioning for a new building was "regarded as a matter of course" in the preliminary plans of the owners. Both office managers and engineers were entirely free to work out all their office layout problems because all daylight and natural ventilation were excluded. There was no need to consider windows, drafts, dirt or dust, the direction of lighting or related questions. Thus, everything could be planned from the standpoint of operating efficiency.

An unusual arrangement designed to promote efficiency is the isolation of all noisy office machines in separate rooms separated by glass panels from the general office space. Such departments as the transcribing department each has its own "private office" immediately adjacent but separated from the general office area.

The heating and air con-

A novel arrangement of the office is the isolation of any noisy equipment in private rooms flanking the general office area. Such departments as the transcribing department (below) thus have their own, air conditioned headquarters. The private offices also flank the general office area. . . . . At the right is a view of the general office area, showing the acoustically treated ceiling, the fluorescent lighting equipment and one of the air diffusers. Air conditioning simplified the arrangement of this office

All photos by Hedrich-Blessing Studio



ditioning requirements of the offices are met by a combination system; there is no direct radiation.

Well Water and Mechanical Refrigeration

Cooling is accomplished by a combination of well water and mechanical refrigeration, which together provide 40 tons of refrigeration. A 253 ft well delivers approximately 80 gpm of 53 F water which cares for 25 tons of the cooling load. The water is circulated through a series of three water coils. The remainder of the cooling load is handled by a 15 hp water cooled compressor installation. The negligible amount of heat produced by fluorescent lighting tubes enables the offices to get along with about 23 tons less refrigeration than would have been required if conventional filament bulbs had been used to obtain the same lighting intensities, it is estimated.

The office air conditioning system handles approximately 16,000 cfm of air to provide six complete air changes per hour. It is designed to maintain 80 F dry bulb temperature and not to exceed 50 per cent relative humidity in the summer, with 25 to 30 per cent in the winter, when humidification is accomplished by means of a steam grid humidifier. Control of temperatures is automatic.

High Velocity Air Diffusers

All the heating and air conditioning ducts are concealed above the ceiling, where high velocity air diffusers —and in the general office, grilles for the exhaust of used air—have been installed flush with the acoustic tile. In the private offices, the return grilles are just above the base molding in the side walls. The roof has 2 in. of insulation which, with a 3 ft attic space, reduces the heat load considerably.

With the installation of this air conditioning system, employees will be able to do better, more accurate work at times when they would otherwise be partially disturbed or distracted by the effects of excessive heat or

numidity. There is no detraction from a well-balanced schedule of operations. As an added measure of health protection as well as providing for the comfort of employees, it is expected the air conditioning system will return the company and employees large dividends.

Psychology of Windowless Rooms

At first thought it would seem that a windowless structure would become oppressive to employees working in such an office. Fully aware of the psychological effect on the occupants of such an office, the designers took adequate steps to counteract it. A comprehensive study was made as to layout, lighting, air conditioning and interior decoration. By the use of color, plate glass partitions between general offices and private offices and pictorial displays, interest and perspective are provided, presenting an effect usually associated with windows.

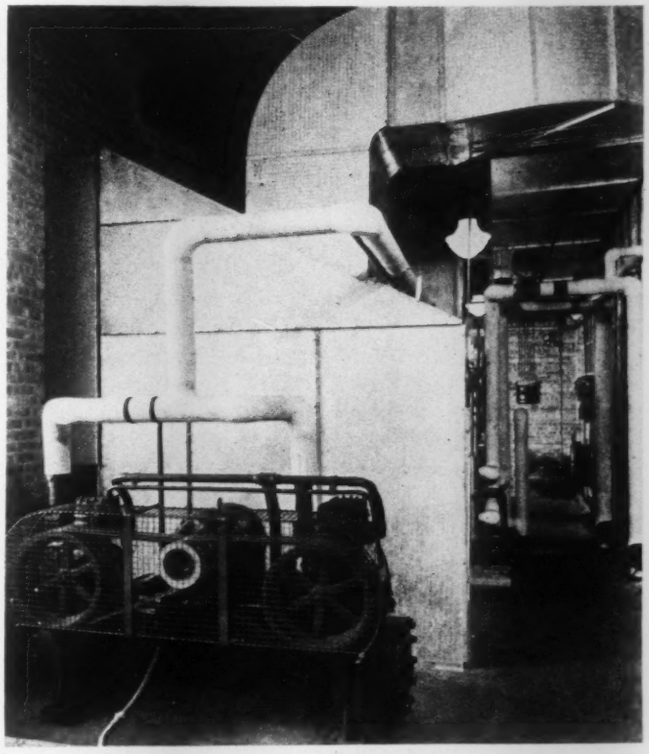
The ceiling height of 11 ft throughout the general office is 18 in. more than in the private offices flanking this area on two sides. This fact, together with reversal of the color scheme applied in the general office, where walls are canary yellow and the ceiling a light green, conveys the feeling of atmospheric space as one looks through glass partitions which separate the private offices from the larger area.

This is further enhanced by the landscape murals displayed on the side walls of the private offices and the 60 ft symbolic gold tone photo mural across the west end of the room where the evolution of All-Steel-Equip products from the raw material to the finished lockers, shop equipment, files, desks, cabinets and other products is depicted.

A narrow band of glass block 72 ft long extends across the office facade on the east. It was installed for architectural effect and as a source of auxiliary lighting. It is equipped with a lightproof blind, which is normally drawn to exclude all daylight.

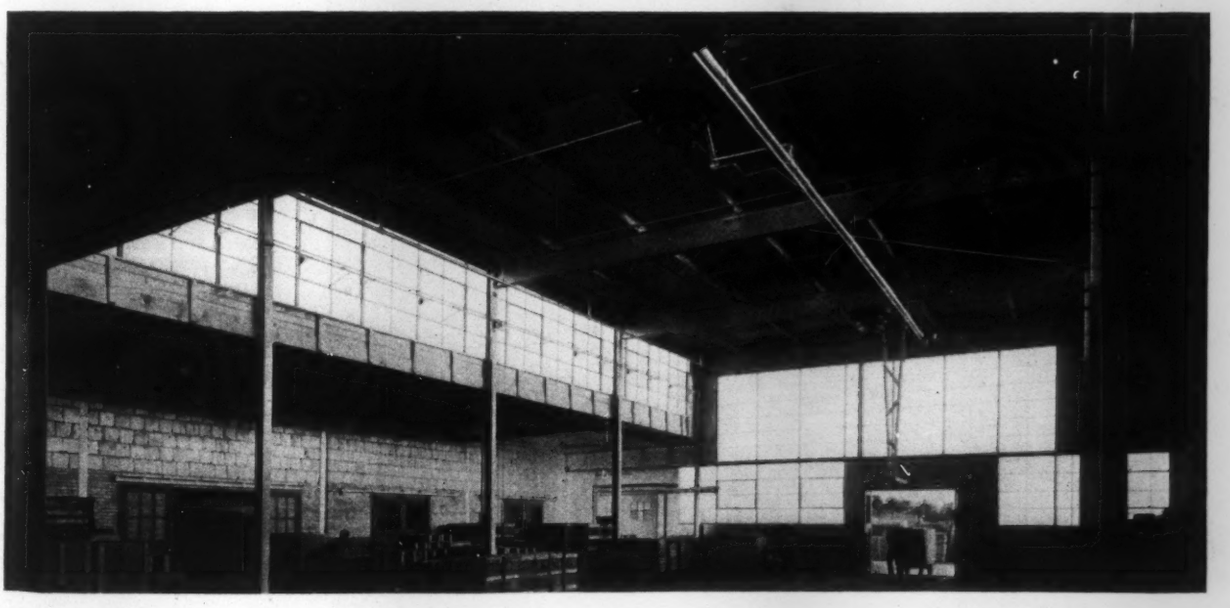
The whole decorating scheme, therefore, is designed to harmonize with the lighting conditions, making them ideal for efficient work. Surroundings have been planned to produce the most wholesome psychological effect. The "cool" light of the fluorescent tubes is balanced by the warmth of the marbleized buff tan asphalt tile flooring and the coloring of the office furnishings.

In order to keep pace with the other ultramodern features of the building, "A-S-E Diplomat" desks and tables and "Aurora" filing equipment are used throughout the offices.



The air conditioning plant serving the offices. Cooling is accomplished by a combination of well water and these compressors

The warehouse, shipping and receiving areas in the new building are heated by unit heaters of the projection type. The units are supplied by steam from the same boiler installation serving the existing plant, which is heated by suspended type unit heaters



Welded Piping Got Attention

. . . at the AWS meeting last month. Fillet welds, carbon-moly piping, preheating, etc., were discussed

SUMMARY

At the 21st annual meeting of the American Welding Society in Cleveland last month, several papers on welding of piping were presented. They included a discussion of fillet welds in piping, welding carbon-molybdenum piping for high pressure, high temperature service, welding copper and red brass, preheating and normalizing, and pipe welding for naval service. A few of the high spots of the piping papers are given briefly here

EACH year at the annual meeting of the American Welding Society the subject of pipe welding comes in for its share of attention. The 1940 get-together of the AWS took place in Cleveland the week of October 20. For the benefit of HPAC readers concerned with pipe welding and who did not attend the sessions, several of the papers are briefly abstracted in the following paragraphs.

Fillet Welds in Piping

The paper by Irving H. Carlson and Eric R. Seabloom[1] covered an investigation of gas and arc fillet welds in piping.

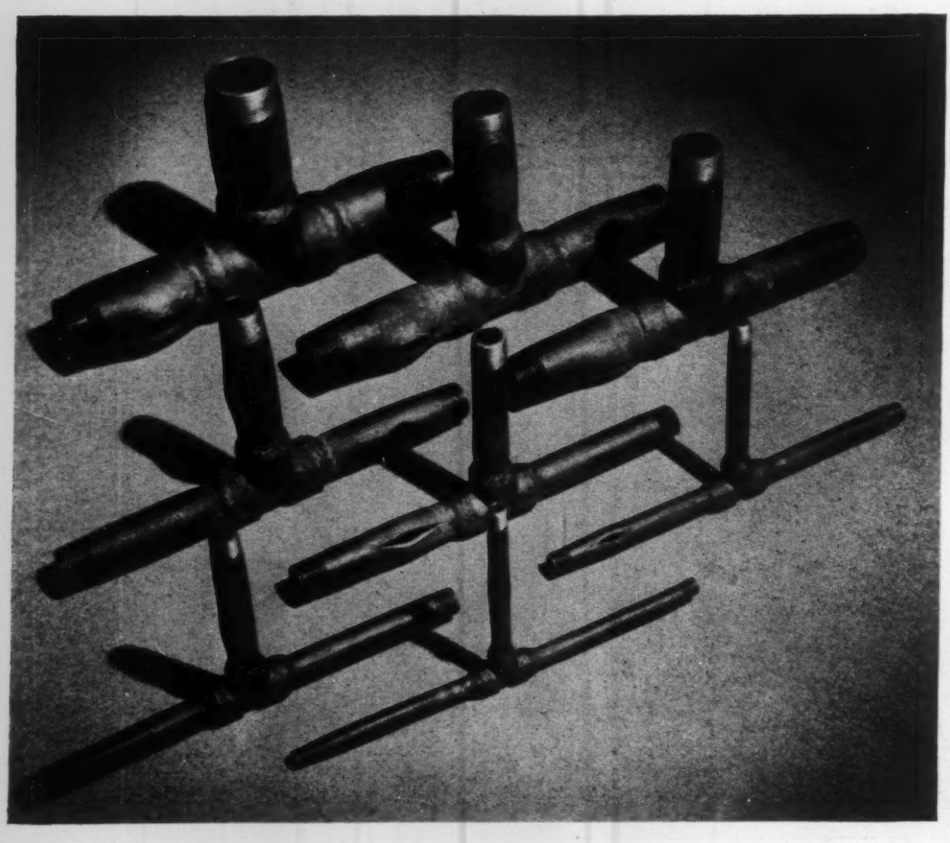
Assembly of piping by means of fusion welding has been employed to some extent for many years. Recently, additional strides have been made in applying welding to pipe fabrication, due to the rise in pressures and temperatures, making welding almost a necessity, and also because numerous fittings and valves designed for welding have appeared on the market. These have generally been used with butt welds.

Fillet welds have only been employed to a limited extent, even though they offer advantages over butt welds, especially on small sizes of piping, due to restrictions placed upon them by various codes. However, the codes are now commencing to recognize fillet welds as acceptable for higher pressures and temperatures, and the tests described in the paper were made in connection with the development of socket type fittings for fillet welding. These consisted of hydrostatic, tensile, fatigue, metallographic and hardness studies. One of the principal phases of this investigation was the determination of weld strength in relation to sockets and pipe.

Of the 264 fillet welded joints subjected to hydrostatic bursting tests, only one fracture occurred in the weld at a pressure equivalent to cause pipe failure; the others failed in the pipe at pressures exceeding the theoretical bursting pressures of pipe by large margins. Assemblies, which included 176 welds, tested under tensile loading up to the ultimate strength of the pipe attachments resulted in no weld failures. Tensile tests were also made on welds having reduced cross-sectional areas to represent welds having defects which might be produced under unfavorable welding conditions, and even these displayed exceptionally high strength.

The hardness surveys made on assemblies of tees and pipe having both low and medium carbon ranges showed that the values were within the range generally accepted for pressure piping, with indications that possible preference should be given to the lower carbon ranges in the medium

[1]Research and Development Laboratories, Crane Co.



Of the 264 fillet welded joints subjected to hydrostatic bursting tests, only one fracture occurred in the weld at a pressure equivalent to cause pipe failure; the others failed in the pipe at pressures exceeding the theoretical bursting pressure of pipe by large margins. This photo shows some typical failures obtained on hydrostatic tests

carbon grade. This was also revealed in the metallographic examinations, as coarser grained structures were obtained with the higher carbon material.

Fatigue tests of fillet welded tee and pipe assemblies brought out the fact that smoothness and proper weld contour influenced the fatigue life more so than the weld metal itself. Due to their smoother contours, gas welds showed longer fatigue life than arc welds, even though coarser grained.

From the results of the investigation, it appears that fillet welds, as applied to piping, can safely be employed in the same manner as butt welds without any restrictions as to pressure and temperature, the authors concluded. It is gratifying to know that codes are recognizing this fact, making possible further application of fusion welding, and thus overcoming difficulties usually encountered in butt welding of the smaller sizes of piping.

Carbon-Moly Piping

In his paper on the welding of carbon-molybdenum piping for high temperature, high pressure service, R. W. Emerson[2] pointed out that the service requirements of power plant piping in 1915 were seldom higher than 200 lb, 500 F. By 1930, a period of 15 years, these requirements were raised to 1300 lb, 750 F, and today steam power plants are operating as high as 1800 lb, 950 F. In view of this fact it is not surprising that power plant materials and their subsequent fabrication must pass rigid specifications and inspection.

His paper continued with a discussion of the effect of molybdenum on steel, the metallurgical effects produced by welding heat, the effect of preheating and stress relieving on qualification test results, joint designs for high pressure piping, and general procedure and operator qualifications. The paper may be summed up with the following conclusions:

Carbon-molybdenum steel is welded using an electrode of the same approximate analysis as the base material; for this reason, the main metallurgical consideration is the effect of the welding heat, followed by rapid cooling, on the hardness and microstructure of the base metal and weld deposit.

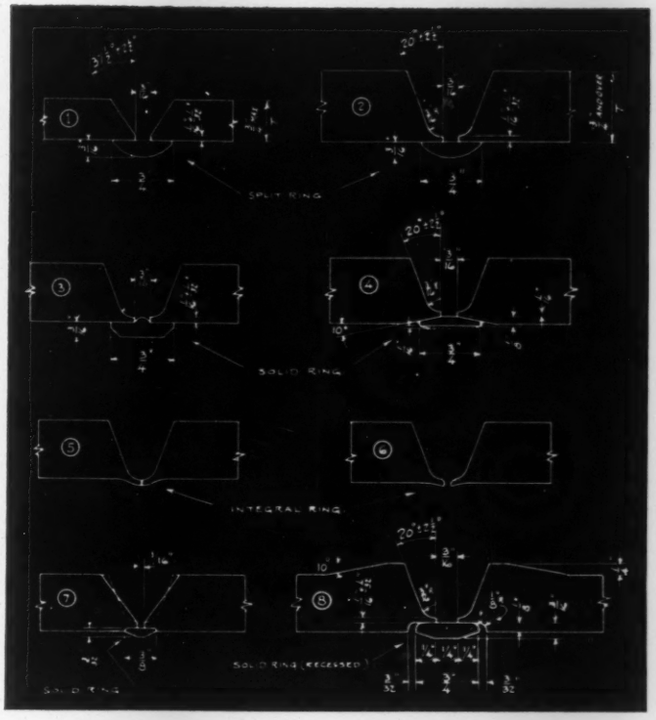
Hardness readings and microstructure examinations on a single bead weld made under severe cooling conditions indicate that the weld-hardening tendencies of low carbon—½ per cent molybdenum steel is only slight. This conclusion was also confirmed by heat treating small laboratory specimens, it being necessary to water quench these specimens from 1925 F in order to produce severe hardening. Air cooling from as high as 1925 F and water quenching from as high as 1650 F failed to produce excessive hardening.

The effect of preheating and stress relieving is readily noticeable on the elongation before failure in free bending. These variables, however, have little, if any, noticeable effect on tensile test results.

Both hardness tests and microscopic examination from a multiple pass weld on a 6⅝ in. OD x 0.432 in. wall pipe which was neither preheated nor stress relieved indicate a structure with a similarity to the air cooled, heat treated specimens previously mentioned.

Proper joint designs for pressure piping require a root opening and ring design such that proper fusion is obtained in the root of the weld, in addition to the fact that the included angle of the welding groove should be sufficient to avoid excessive undercutting and thus avoid the possibility of trapping slag along the side walls of the weld.

[2]Pittsburgh Piping & Equipment Co.



Joint Designs for Pressure Piping

Nos. 1, 2 and 8—Pittsburgh Piping & Equipment Co.
Nos. 3, 5 and 6—H. N. Boetcher, HEATING, PIPING AND AIR CONDITIONING, November, 1939.
No. 4—Arthur McCutchan, HEATING, PIPING AND AIR CONDITIONING, March, 1939.
No. 7—ASME power boiler code.

Joint design has been considered by many individuals and is believed to be largely a case of personal preference, it was stated.

Joint design may be broken down into actual groove design and backing ring design. The groove designs shown in the sketch, Nos. 1 and 2, have been published as a recommended practice, ASA Standard B16e 1939 and are considered to fulfill the latter of the two general requirements. Due to lack of agreement on a backing ring design which will assure a thoroughly fused root, standardization of such has been slow. The main requirement of a backing ring is that it have sufficient metal cross-section to avoid burning through the ring and still produce a "minimum restriction to flow" in the pipe. This factor is dependent upon the contour of the inside of the ring and/or to what degree, if any, the pipe ends are recessed for the backing ring.

The designs illustrated were shown essentially for the purpose of discussing ring design.

For low pressure piping a split band ring can be used to good advantage and with but little or no extra cost. Nos. 1 and 2 are of this type. A ring of this cross-section is believed to have advantages over a split band ⅛x¾ in. rectangular cross-section. This ring is $\frac{3}{16}$ in. thick through the section where maximum thickness is needed as too frequently a ⅛ in. ring will burn through. The ring being "radiused" results in a minimum restriction to flow.

Designs of the types shown in Nos. 3 and 4 which involve machining of the backing ring are usually of the solid ring type and are used for higher pressure piping than the split ring type. The raised portion in the center of the ring (No. 3) materially aids in obtaining the proper spacing of the pipe but increases the possibility of a poorly fused root. Rings of the type shown in No. 4 with various modifications as to width thickness and angle of bevel are being quite widely specified for high pressure piping. This type of design gives good results and has the advantage of wedging the pipe to the ring as the weld contracts. This type of ring does, however, require extremely accurate machining of both pipe ends and the ring, if the desired root spacing is to be maintained. It is believed that an additional $\frac{1}{16}$ in. added to the thickness of this ring as shown by the dotted line would be beneficial.

Nos. 5 and 6 involve the rolling of a lip on the pipe which produces an internal upset. This internal upset is considered as an integral backing ring. The lip being machined to close tolerances for a given nominal pipe size simplifies the problem of alignment of pipes with slight variations in actual ID. In No. 5 the lips are butted tight and fused by means of the metallic arc. The lips are spaced in No. 6 and the first bead is deposited using oxy-actylene welding. These joints not having separate backing rings, however, are believed to be unacceptable for boiler code fabrication.

Ring design No. 7 is one of two designs suggested by the boiler code for pipe sizes up to and including 5½ in. OD, and larger if applicable. This design does not allow for weld shrinkage and it seems that it would cause an upsetting of the backing ring or possible cracking of the weld. In addition to this a $\frac{1}{16}$ in. root opening is believed to be insufficient to be sure of sound fusion at the root of the weld. The other suggested design (not shown) involves the use of a tapered ring in addition to a raised section for spacing purposes. The raised spacer defeats the purpose of the tapered ring unless both pipe and ring are machined with impractical accuracy. The cross-section of these rings is insufficiently heavy for pipe sizes larger than 5½ in. OD.

It would be desirable to have added to the boiler code rules acceptable designs of backing rings for pipe sizes 6 in. and larger. These rules should preferably allow a root spacing of $\frac{3}{16}$ in. with a minimum ring thickness of ⅛ in. and preferably $\frac{3}{16}$ in. over that portion of the ring which is directly below the root opening.

Joints of the type shown in No. 8, with slight modifications, are used for high temperature, high pressure service by a number of fabricators. This type of joint has an external upset with a partially or completely recessed backing ring.

Welding Copper and Red Brass

J. J. Vreeland and J. Babin[3] spoke on welding of copper and red brass, as considerable interest has been shown in the welding of copper and red brass in the past year for chemical equipment, pipe lines, pressure vessels and similar applications. In the fusion welding of copper considerable information was given concerning the results obtained when using electrolytic copper and deoxidized copper. Methods of welding, both gas and carbon arc, were covered.

The paper also dealt with true fusion welding of red brass, using a welding rod immune to dezincification failures under severe corrosion service conditions. Satisfactory strengths are obtained to warrant the use of this procedure for all pipe line installations, they stated. Carbon arc welding of red brass was also discussed, showing that this method of fabrication may be used with satisfactory results. Most of the welding information contained in the paper was obtained by the welding in all positions of standard pipe sizes of red brass. Strengths obtained for non-reinforced welds exceeded 80 per cent of the minimum specified for the base metal.

[3]Chase Brass & Copper Co.

Preheating and Normalizing

C. J. Holslag[4] said in his paper that preheating is necessary for cast iron, alloy castings and alloy tool steels. In some welding applications cracking and warping can be prevented and controlled by preheating, in other places by stress relieving, and in still others by both. High pressures and temperatures in some process industries result in greater efficiency, but these are only possible with vessels and piping strong enough to withstand such combinations of pressures and temperatures. Welding is the solution, he said.

Welding for Naval Piping

Bela Ronay[5] presented an extensive paper on investigation of welding for naval piping, reporting research on the welding of thin and thick wall tubing.

The investigation indicated, among other things, in the personal opinion of the author, that efficiency of welded joints in thin wall tubing cannot be readily established only on the basis of static tension tests; sleeve type joints possess the best joint efficiency; non-streamlined inserts constitute an impediment in small diameter lines, cumulative value of which is high; oxy-acetylene welding is preferable in fabrication of small diameter lines; and local stress relieving of small diameter joints does not materially improve efficiency but appears to insure more consistent performance.

The investigation of heavy wall tubing showed the development of a sound filler metal at the root zone is a major function of the joint design and neither manipulation nor technique appeared to compensate for lack of root spacing. It further showed that using electric arc welding the soundest filler metal is deposited when each increment is deposited maintaining the longest current dwell applicable without undercutting. Moderate preheating promotes development of sound filler metal and tends to lessen difficulties of welding in positions other than the horizontal, rotated.

Assembling tube joints by tack welding is not a reliable method to develop sound filler metal throughout the entire root zone, it was stated, and development of sound root conditions is substantially promoted by the use of suitable clamps. Several methods may be applied to reduce residual stresses to negligible quantities; it appears that the most reliable method for local stress relieving is by induction heating, he said.

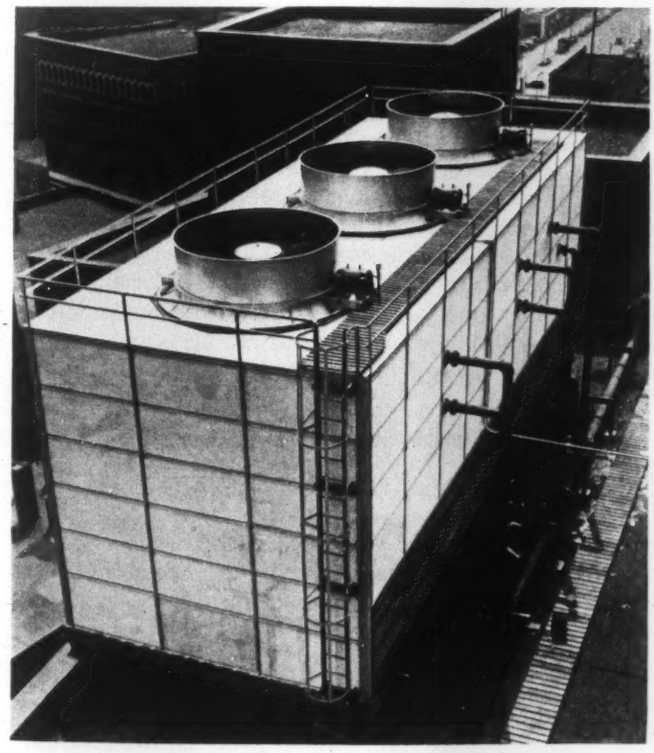
[4]Electric Arc Cutting & Welding Co.
[5]U. S. Naval Engineering Experiment Station.

Air Conditioning Design for Future Requirements

Harry Boyd Matzen, Consulting Engineer, Describes How Present and Future Needs of a Department Store Are Met

THE new air conditioning system for the May Co. department store's Euclid-Prospect and Ontario St. buildings in Cleveland was designed entirely from the standpoint of *future* requirements. At present the third floor and the restaurant on the fifth floor of the Ontario St. building—known as the Spanish Room—are the only sections actually air conditioned, although the main zone equipment, the refrigeration system, the chilled water and cooling tower water systems and the cooling tower, the main supply and return risers, the compressed air control system and the electrical circuits are all installed and are of sufficient capacity to air condition the second, fourth, fifth and sixth floors in addition. Any zone on any of these floors can be air conditioned, without in any way affecting the conditions maintained in any other part of the building, by simply installing the booster fans, duct distribution system, temperature control and recording devices and the final electrical connections. Thus, these additional spaces can be equipped quickly and with minimum interference to business.

The cooling tower has three cells, two of which are used for cooling condenser water for the new air conditioning system. For flexibility, the fan for one of these cells is driven by a two speed motor and the other fan has a constant speed motor.



SUMMARY

The new air conditioning system for the May Co. department store's Euclid-Prospect and Ontario St. buildings in Cleveland was designed entirely from the standpoint of the future requirements. At present, one floor and a restaurant on another floor are the only sections actually conditioned, but any zone on any of the other floors served by the new system can be completed as required, quickly and with minimum interference to the store's business. . . . The system was planned so that no equipment would occupy floor space in the sales area. The air treating equipment is situated in penthouses on the roof, the centrifugal water chilling apparatus is in the basement and the booster fan units are suspended from the ceilings in inconspicuous locations. The water cooling system is split into two units, each of 400 ton capacity, to achieve economical operation

The entire air conditioning system was designed with the object in view that no equipment should occupy floor space in the sales area. All the air treating equipment is on the roof in penthouses which were built as additions to existing elevator penthouses. The water cooling systems are in the basement directly under the cooling tower. The chilled water piping mains are on the ceiling of the eighth floor, which is a stock floor, and the booster fans are suspended from the ceilings in the sales areas in inconspicuous locations.

Of particular interest is the duct distribution system in the sales areas. The ducts are constructed of galvannealed sheet metal and have the appearance of plastered ducts (although no ducts in the conditioned area were plastered). The design is such that the actual size of any duct does not exceed 24 in. × 24 in. These can be combined to give any desired air carrying capacity up to approximately 30,000 cfm.

Split Into Five Zones

The air conditioning system is divided into five vertical zones. Zone 1 serves the northeast section of the Euclid-Prospect building, zone 2 serves its southeast section, zone 3 its southwest section, zone 4 its northwest section, and zone 5 serves the Ontario St. building.

The equipment for each of the zones consists of an outside air intake with stationary louvers and screen, minimum and maximum outside air dampers, preheating coils, a return air opening with dampers, spray water type dehumidifiers, air filters, main supply fan, fan motor and drive and fan starter.

The air conditioning system is divided into five zones serving the second to sixth floors inclusive of the Euclid-Prospect building and the Ontario St. building. At present the only areas actually conditioned are the third floor, and the Spanish room restaurant (shown here) on the fifth floor. As required, the other areas can be completed with minimum interference to the store business.

At the intake of each main supply fan are the automatic throttling dampers actuated through a static pressure regulator situated in the main supply duct.

The air conditioning equipment for zones 3 and 4 is combined, except that there is a separate main supply fan for each zone, with automatic throttling dampers at each fan inlet actuated by a static pressure regulator in each main supply duct to each zone.

At each outside air intake there is a thermostat in the minimum outside air supply. The minimum outside air dampers and the return air dampers open full when the main supply fan is started and remain fully open as long as the fan is in operation. These dampers likewise close when the fan is shut down.

The thermostat in the minimum outside air supply is set for 55 deg. There is also a dew point thermostat in the fan discharge, and this is set for 42 deg. When the outside air is at or below 55 deg and above 42 deg, the thermostat in the minimum outside air allows the maximum outside air dampers to open in addition to the minimum dampers and closes the return air dampers. When outside air reaches such a temperature that the air leaving the fan discharge is at 42 deg, then the dew point thermostat in the fan discharge operates the maximum and return air dampers and also controls steam admission to the preheater coils to maintain 42 deg at the fan discharge. This is for winter operation.

In summer, or at such times when the outside air is above 55 F, the minimum outside air dampers and the return air dampers only are fully open. This provides for adequate ventilation. In spring and fall when the outside air temperature is at or below 55 deg and above 42 deg both the maximum and minimum dampers will be open full and the return air dampers closed. This is the season when cooling can be obtained entirely by evaporation in the spray dehumidifiers, without requiring chilled water, by using the maximum quantity of outside air, i. e., the full capacity of the main supply fans.

At each zone there are vertical supply and return air ducts, with connections provided at each floor from the second to the sixth inclusive.

At present, since the third floor and the Spanish Room only are air conditioned, these vertical supply air and return air ducts serve these areas. At each zone on the third floor and at zone 5 on the fifth floor (Spanish Room) there are booster fans delivering a constant quantity of air at all times, fan motors, drives, starters, a connection from the main vertical supply duct and a recirculating air connection for recirculating air directly from the conditioned area, and a return air grille.

There is a mixing chamber at the inlet to the booster fans, with three sets of dampers. One damper controls the amount of air taken from the main vertical supply duct, and this damper in turn is connected with a recirculating air damper, so that when the supply air damper opens, the recirculating air damper closes. The third damper is a hand damper for fixing a definite amount of recirculated air at all times. The damper controlling the air supply from the main vertical duct is also set so that it cannot at any time fully close, assuring a minimum supply of air for ventilation at all times. These dampers are controlled by a thermostat at the return air grille in each zone.

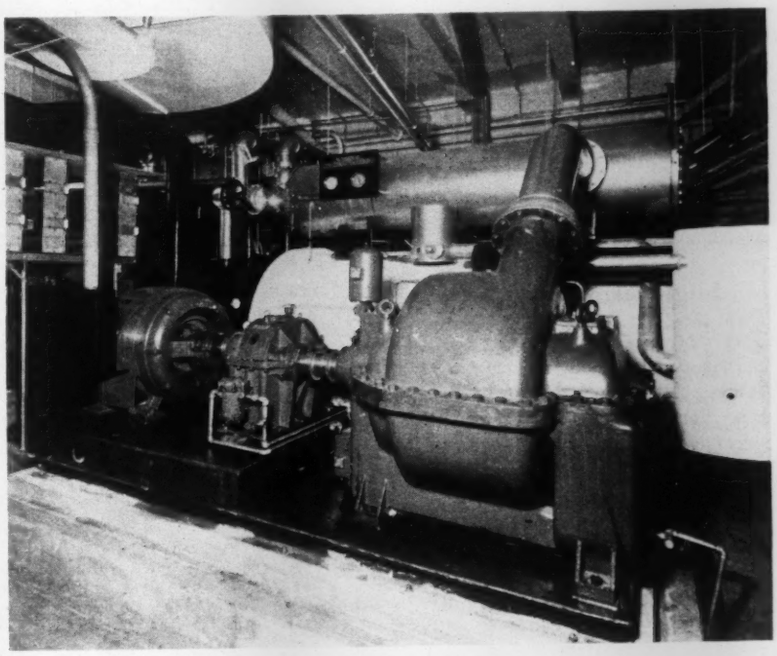
On the third floor at zone 2, there are two booster fans, dividing zone 2 into two subzones, namely zone 2, which is the extreme southeast section extending from the elevators to Prospect Ave., and zone 2A, which is the entire shoe department.

The thermostats at each zone are set at approximately 75 deg.

Summing up, it is seen that the zone booster fans handle a constant quantity of air irrespective of the season. However, the damper in the conditioned air supply is set for a minimum supply for good ventilation. For tempering the air at the zones, sufficient air is recirculated, this being controlled by the thermostat in the zone which controls both the conditioned air supply and the return air. This makes for a simple control and also makes use of the sensible heat given up by lights and people. Direct radiation is used for outside wall losses.

Two Water Chilling Units

The centrifugal water cooling system is in two units each having a capacity of 400 tons when cooling 1200 gpm of water from 53 to 45 deg and when furnished with 1200 gpm of cooling tower water at 85 deg. These units, installed in the basement, furnish chilled water to the spray dehumidifiers. Each of these units is driven by a 350 hp slip ring, variable speed motor. The chilled water pumps and the cooling tower pumps are cross connected so that either pump may be used with either water cooling unit. In winter, when air washing and



The centrifugal water chilling equipment for the new system is installed in two units of 400 tons capacity each, each driven by a 350 hp slip ring, variable speed motor. Chilled water and cooling tower pumps are cross connected so that they may be used with either water cooling unit. This arrangement was used in order to save power

humidification only is required, but one of the chilled water pumps need be operated and then by bypassing the water coolers.

The condensers for the water cooling systems are of the shell and tube type. Each condenser is equipped with a condenser pump for pumping water through the condenser from an induced draft, spray type water cooling tower on the roof of the building directly above the centrifugal water cooling system, and delivering the water back to the tower.

The water coolers for the water cooling systems are also shell and tube type, and each is equipped with a pump for pumping water from the spray dehumidifiers, through the water coolers and thence back to the dehumidifiers.

The cooling tower is arranged in three cells, two of which are for cooling condenser water for the water cooling systems described above. One of these two cells has a two speed fan motor and the other a constant speed motor. The third cell of the cooling tower is used for cooling condenser water for an earlier air conditioning installation and for an ammonia refrigeration machine. Each of these units has its own pump and spray system.

The purpose of using two water cooling systems, two condenser pumps, two chilled water pumps, and two cells for cooling condenser water is to be able to operate economically by saving power, because of the extremely variable load due to changeable outside weather conditions and wide ranges of interior load due principally to people.

Control from Central Panel

The electrical service for driving motors is furnished by the Cleveland Electric Illuminating Co. It is brought into the building at the location of the centrifugal water cooling systems and is 4600 volt, 60 cycle, 3 phase, reduced to 440 volt, 60 cycle, 3 phase, through three 550 kw air cooled transformers set on a platform in an open vault directly above the condenser pumps.

This service is then brought to a main switchboard, where the meter is situated, and from which the power circuits are distributed to the various motors for driving equipment throughout the building. At this board there are capacitators with a power factor indicator for correcting power factor; this is necessary because of the type of motors used, and because of the variable load required in chilling water during the summer cooling season.

Near the chief engineer's desk is a control panel which has pushbuttons for starting and stopping the various motors, and also pilot lights to indicate the motors that are operating (except the motors driving the centrifugal compressors). On this board are also electrical temperature recorders for recording cooling tower water, chilled water, outside air, return air, dew point, and zone temperatures, from resistance thermometers situated at various points.

There are also indicating thermometers adjacent to the resistance thermometers so that performance may be observed readily. The charts upon which the temperatures are recorded are permanent log records, and the only other records that need be kept to obtain complete performance at all times are the high and low pressure readings at the water cooling systems, as well as oil pressure and oil temperature readings. These are recorded on a prepared log sheet by the operator of these machines.

There is a motor driven air compressor, which operates 24 hr per day, in each air conditioning penthouse. These air compressors supply compressed air to the temperature control system in each zone through copper tubing with branches at each floor.

Air Cleaned Electrically

Air filter units combining electrical precipitation with an automatic, continuous self-cleaning viscous filter are used because the store is situated very close to the Cuyahoga Valley district, where there are many industrial plants emitting smoke and fumes. In addition, soft coal is almost universally used in heating plants in Cleveland. Therefore, smoke, soot and fumes had to be considered because of the large volume of outside air required for ventilation. This is a matter of real concern in a department store where expensive and fragile garments are displayed for sale. The cost of cleaning merchandise and interior decorations is a large item of expense during all seasons of the year. It is expected this item of expense will be greatly reduced.

The air filters are situated between the spray dehumidifiers and the main supply fans of the various zones.

"OPEN FOR DISCUSSION"

Communications to the Editor

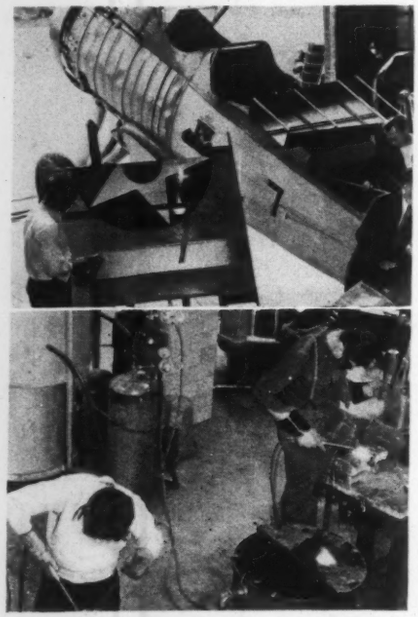
Engineering Preparation

THE EDITOR—

This is admittedly an age of specialization. No longer do we have general practitioners. The doctor of medicine selects some part of the human anatomy or some ailment to which the body may be subjected as his field of application and qualifies himself as a specialist in that field. Attorneys at law prepare themselves to specialize in the defense or prosecution of criminals; in corporation law; in tax matters; in interstate commerce; matters of real estate. General practitioners are found only in the smaller communities where everything must be grist that comes to the mill.

It has come to be as true in the field of engineering as in any other field. No one today can possibly be expert enough in all phases of engineering to be able to qualify as competent in all fields—design, construction, operation. To cover the wide variety of experiences and applications found in engineering is beyond any one human mind's comprehension. It might not be so utterly impossible were it not for the wide and rapid changes that are constantly taking place in science and engineering through research and the applications of the new knowledge gained thereby. New materials and old materials put to new uses appear on the market almost every month. Even heating, piping and air conditioning—which is but one subdivision in the field of engineering—is now covering such a wide range and is finding so many applications not thought of a few years ago that it is taxing the ability and capacity of the engineer who specializes in this subdivision. The field of air conditioning for comfort has been quite thoroughly plowed and seeds have been sown, but the harvest has not yet all been reaped. It is in new applications in industry and in control of plant and animal growth where research must be carried in the future and where the most startling developments are likely to be found.

Preparation is the keynote today; the needs of national defense have emphasized it until it is prominent in our national thinking. Schools and colleges are encouraged through federal agencies to establish and carry on intensive training courses that are approved by the United States government for essential defense crafts, and thousands of young men are today receiving intensive vocational training in engineering science and practices that will serve them well after the emergency need for military defense has passed. But long before we became defense-minded the air was filled with



"Vocational training that develops skill with the hands, that combines the knowledge of what to do and how to do it, will toughen the fiber and make young America self-reliant," says John Howatt. These photos, taken at Lane Tech, Chicago, show men at work in connection with the Chicago Board of Education's new national defense training program

declarations of the need of more vocational training—more skill in the art of actual work and less in the knack of talking about it. For some time complaints have come from industrial leaders that schools and colleges are not properly fitting young men and women to earn a living—that there is a lack of coördination between theory and practice.

It is recognized that school years are the years of study and life thereafter the years of application, but industrial leaders have asserted men and women leave schools and colleges without ever having had an opportunity actually to apply themselves in work and are not prepared to enter the competitive fields of commerce. There is not enough coöperation and coördination between educational institutions training men and women for life work and the industrial or business organizations where they must hope for employment. Education of young engineers should be a training that includes not only the fundamentals and theory of engineering principles, but which should include also a certain amount of training and application in the field. Too often the school text was prepared more than 20 years ago; in this era of rapid changes in knowledge and belief of what is true in science, texts become outmoded in a decade.

One of the practical means that may be used in tying students to work outside would be an extension of the practice of some schools and colleges in bringing in at frequent intervals, outside speakers from business and industry who are not circumscribed in their ideas and in their diction by the long years of tradition of the classroom. Both the speakers and the student body generally approve of this practice.

College and school training beyond the second year in high school might be a 12 month per year process with three months of the 12 applied on an assignment in some suitable industry through an arrangement that would give the students credit for the period of application just as they would receive credit for time spent in the shop or laboratory. Some colleges are already doing this. This produces a graduate trained in both head and hand.

Young people seeking a job are handicapped when they are merely handymen without any special skill. The applicant for a position who says he can do anything is not selected because the employer realizes such a one knows nothing well enough to hold the job. Vocational training is the solution offered and accepted today; and vocational training can be applied to nearly every occupation. This nation is known as an industrial nation, but more persons are engaged in agriculture in the production of food than in any other business. Today agriculture cannot be the haphazard gamble it once was if success may be

Readers of HEATING, PIPING AND AIR CONDITIONING are invited to contribute their views to these "Open for Discussion" pages, which will appear from time to time.

expected. Those entering this field need vocational training as surely as do those entering the field of medicine, where young doctors must serve as internes.

America is charged by some critics with raising young people who are soft. Vocational training that develops skill with the hands, that combines the knowledge of what to do and how to do it, will toughen the fiber and make young America self-reliant. This should be our preparation for our future. — JOHN HOWATT, Chief Engineer, Chicago Board of Education. Member of HPAC's Board of Consulting and Contributing Editors.

Panel Heating

THE EDITOR—

In reference to Dr. Giesecke's article in the October issue, where he credited me with suggesting the use of warm air for panel or radiant heating, I want to state, for the record, that the idea of a blanket of warm air was suggested to me during a discussion at the Cleveland meeting of the ASHVE last January. Who made the suggestion I am unable to recall but it started a train of thought and seemed to me to offer a possible solution to some of the problems of warm air heating.

I believe that the warm air industry in the past has put in quite a few such systems without realizing it. Walls containing heat stacks are certainly radiating panels and in my opinion the fairly satisfactory results secured by some of the older installations, where circulation and air volume were definitely below any possible accepted standard and air temperature was extremely high, were due to radiant heating from ceilings and walls.

Referring to Dr. Giesecke's calculated air volume and temperature to be employed in the room given as an example, a 10 deg temperature difference between entering and leaving air would unquestionably be excellent from a performance standpoint but would mean about four times the air volume usually employed for conventional installations. I wonder if acceptable results could not be secured with about one-quarter of the volume, an entering temperature of 139 F and a leaving temperature of 99 F, instead of 124 F and 114 F, respectively. I of course realize that we would then have a much less uniform ceiling temperature but the total would be the same and by location of inlets where the higher temperature would be adjacent to greatest exposures this might be desirable.

Probably the application of the air blanket panel idea to corners of rooms, bays and other locations where conventional systems have failed to secure comfort even when proper temperature was maintained will enable the engineer to solve many perplexing problems. In other words, we would have a warm air split system with air blanket panels only where needed.—EDWIN A. JONES.

Windowless Buildings Not New

THE EDITOR—

At the John Crerar library in Chicago recently I ran across some references which re-impressed me with the truth of the old adage that "there is nothing new under the sun." As engineers, we have felt quite proud of our new windowless office buildings designed for economy in air conditioning, and in the case of our newer factories, to facilitate wartime black-outs as well. But during the reign of King George II there were many windowless buildings in London, due to the "window tax." This tax was first levied in the year 1697 to compensate for the clipped and defaced coins in the re-coinage of silver. Strange as it may seem, this tax was not repealed until 1851.

In 1752, Dr. John Pringle installed a ventilating system in Newgate prison consisting of individual ventilating ducts from each prison cell to a central duct leading to the roof. A large exhaust fan powered by a wind mill was mounted at the duct outlet and the foul prison air was exhausted from the cells. Pringle was one of the outstanding surgeons of his time and was much interested in the improvement of hospitals and prisons. His associate in this work was the Reverend Stephen Hales, an outstanding physiologist and preacher. Their ventilating system was planned to control the spread of "jail fever" by removing contaminated air from the cells. Many of these early investigators had never heard of "bacteria" but they shrewdly suspected that miasmas or some other air-borne agent contributed to the spread of certain disorders.

I thought that these ideas might be of interest and if you think they are you are at liberty to publish them.—H. C. MURPHY, Vice-president American Air Filter Co., Inc. Member of HPAC's Board of Consulting and Contributing Editors.

Boiler Ratings

THE EDITOR—

The article on boiler ratings by Kalman Steiner and Fred Ravnsbeck, published in the October HPAC, clearly emphasizes a point we have been harping on for many years. Boiler rating and boiler selection are two separate and distinct things. The Heating, Piping and Air Conditioning Contractors National Association is more interested in boiler selection and therefore publishes net load recommendations for heating boilers. In computing the net load recommendation, manufacturers ratings are ignored except where such ratings are based on generally accepted standards such as the SHBI and the IBR codes.

We have often stated that we do not believe that any single rule for selecting the proper boiler capacity will ever be devised that will be suitable for all conditions; therefore it will always be necessary that some intelligence be displayed in proper boiler selection.—H. M. HART, Chairman, Boiler Output Committee, Heating, Piping and Air Conditioning Contractors National Association.

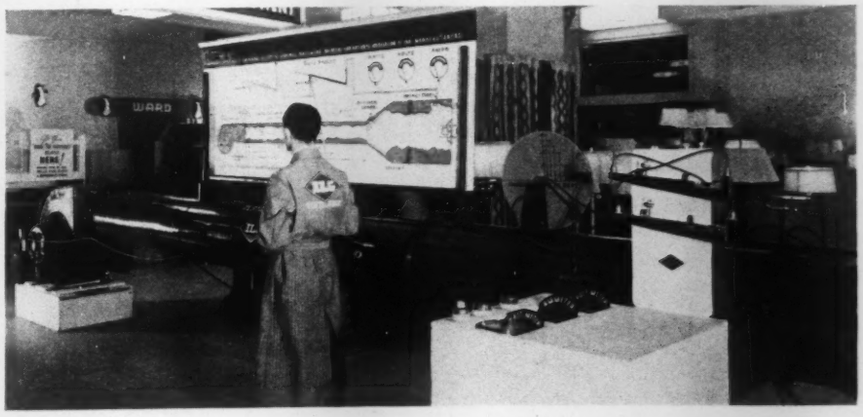
Standard Fan Test

THE EDITOR—

What we believe to be the first public demonstration of the standard fan test adopted by the National Association of Fan Manufacturers and the American Society of Heating and Ventilating Engineers was given recently, at the show rooms of the Commonwealth Edison Co., Chicago. The set-up is illustrated in the accompanying picture.

Publicized as a feature of an air conditioning and ventilation show held annually for the public by Commonwealth Edison, the fan test demonstration proved to be interesting both to the architects and contractors who were given special invitations and to the general public.—C. W. DEXTER, Ilg Electric Ventilating Co.

Public demonstration of standard fan test



It's All Done With Mirrors

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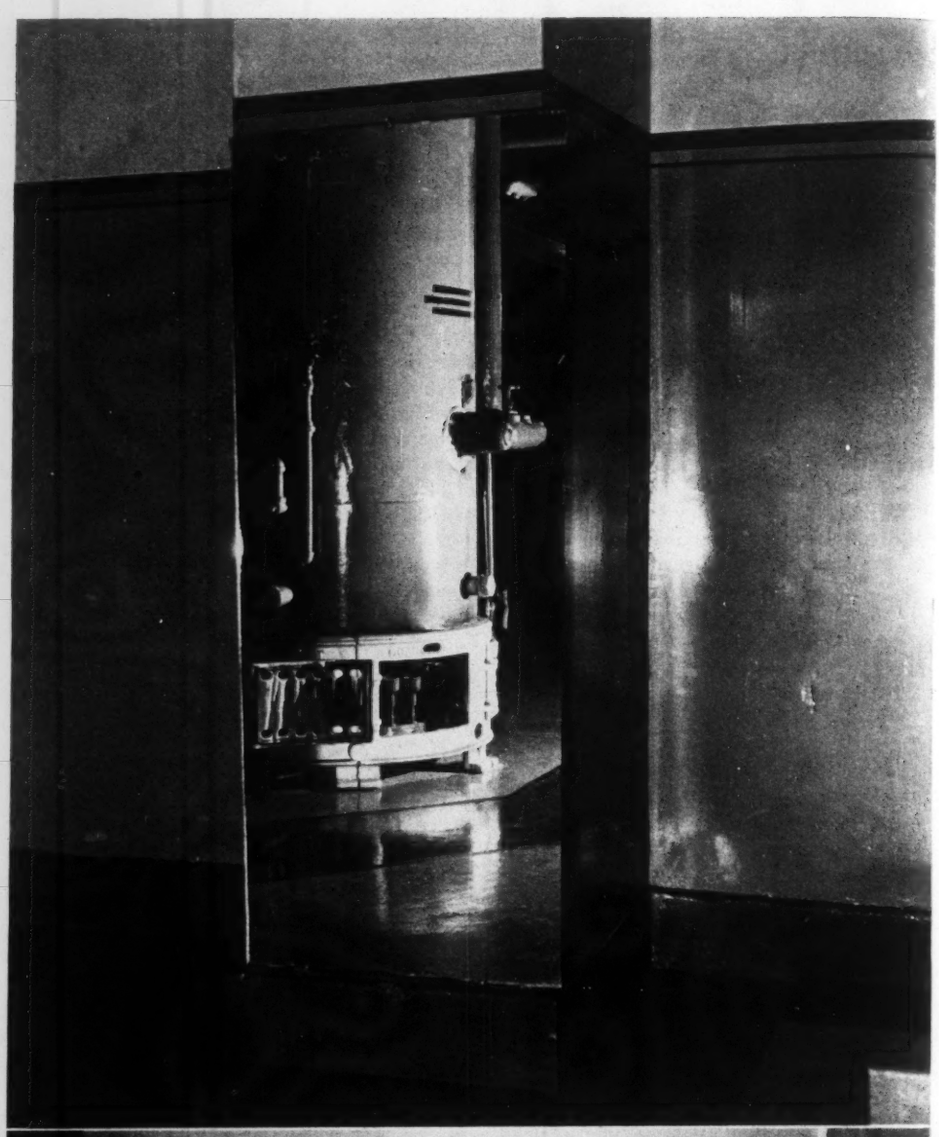
C. D. Scott, engineer and superintendent for the Foreman building, Los Angeles, Calif., uses several mirror devices in his boiler room which lead to savings in fuel, time and trouble, according to J. Edw. Tufft in the magazine Buildings and Building Management. The top view shows a mirror so placed that it reflects the gas burner unit of a vertical boiler. No one has to guess whether the burner is on



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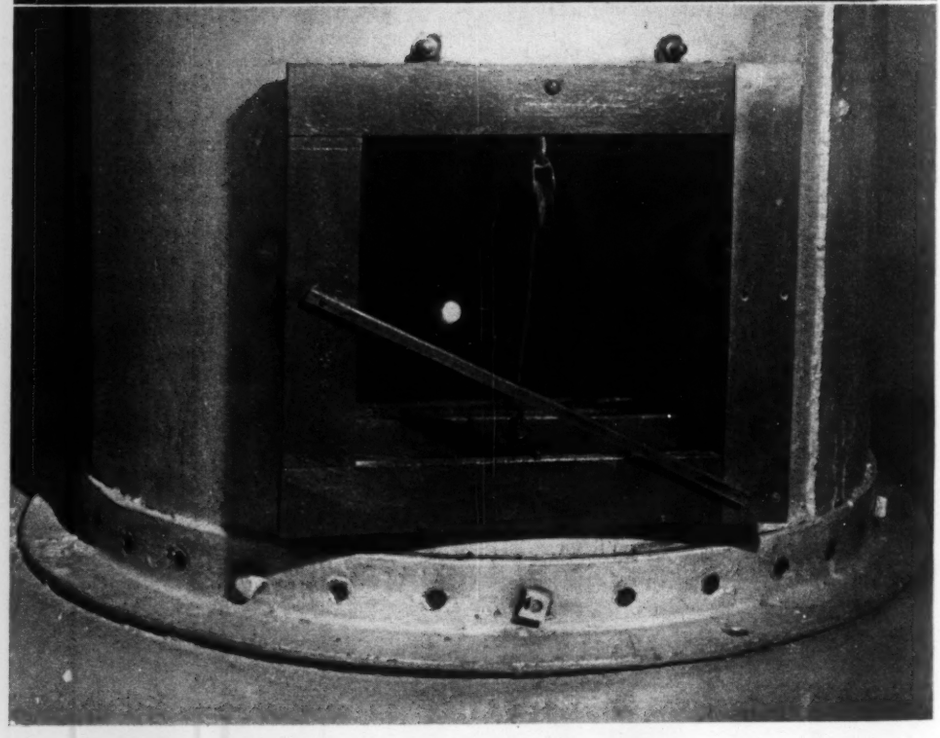
The lower view shows a periscope arrangement at the bottom of a 200 ft stack providing a view of the interior of the stack, and a "blue moon" of sky when stack conditions are just right. An automatic balanced damper is also used, and the damper and mirror arrangement is credited by Mr. Scott with having much to do in keeping the fuel oil consumption at a minimum



School Heating and Ventilating

Unusual method of air distribution and centralized control feature system described by Meryl L. Todd*

SUMMARY

The Longfellow elementary school, Waterloo, Iowa, is a strictly modern building costing approximately $350,000. It was built to replace two or three obsolete grade schools and includes some 28 classrooms, an auditorium, gymnasium and offices, accommodating about 1000 students. The two story structure is approximately 300 ft long, enclosing about 797,365 cu ft. . . . Every effort was made to coördinate the heating and ventilating system and to make it as modern as the building itself. It was designed for complete automatic control of the temperature, quantity and quality of the air within the building. The entire system was zoned to maintain a definite standard of air quality throughout the building with a maximum of operating economy. The method of air distribution—described here—is somewhat unusual and considerable interest has been shown in it. Conditioned air is admitted into each classroom upwardly along the outside walls, the temperature being controlled by individual room thermostats. . . . The design of the boiler room and equipment spaces, limited by site conditions, took into consideration space and appearance. All equipment and material, with the exception of those pieces requiring regular observation or attention, were either partially or completely concealed. There is complete automatic continuity of coal flow from the storage bins to the stoker hoppers, and from there into either or both boilers, as determined by the automatic control

THE heating and ventilating installation for the Longfellow elementary school, Waterloo, Iowa, consists essentially of an automatically operated boiler room (as described in the October HPAC) and a zoned central heating and ventilating system with complete temperature control. The method of air distribution is somewhat unusual, and considerable interest has been shown in it.

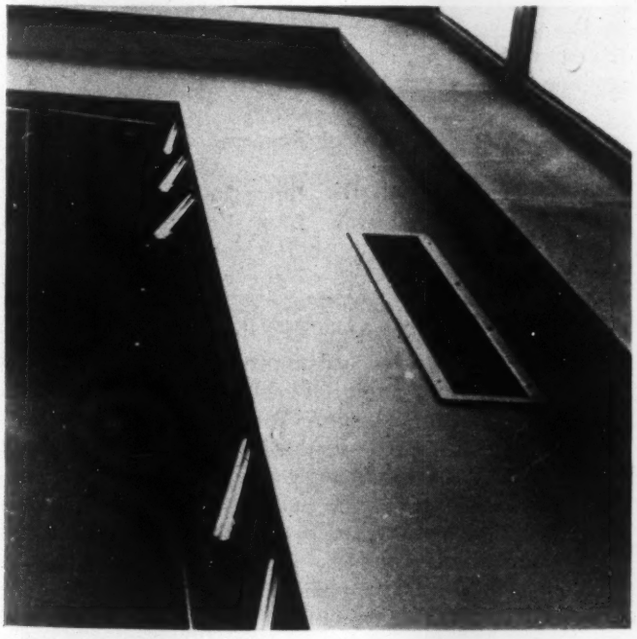
From the main zone supply duct the air is uniformly distributed to the branch ducts leading to the classrooms. In each branch take-off is an automatically controlled booster coil of the extended surface type. The branch duct, taken from the top of the main supply duct, splits to provide two outlets along the outside walls of each average classroom of 40 students.

The branch ducts for the first floor rooms extend parallel to the main duct until they are opposite the openings to the classrooms. From there a horizontal, acoustically insulated branch extends at right angles, connecting with the classroom opening beneath the building.

The branches from the main supply duct for the second floor involve a similar booster coil arrangement and run parallel to the main duct above the first floor branch duct until in line with the openings that extend vertically from the center of the building behind the locker space on the first floor to the floor slab of the second floor. The classroom ducts are carried across the ceiling of the first floor between the concrete joists. There are two branch ducts, fully insulated and approximately 20 in. by 8 in. in size, to each classroom. Along the outside wall these connect through the floor to the distribution cabinets as on the first floor.

*Consulting Engineer.

Air is distributed in each classroom from two special acoustically treated cabinets situated along the outside wall, or from similar size acoustically lined spaces built into the cabinet work



Special Air Distribution Cabinets

The air is distributed in each classroom from two acoustically treated cabinets situated beneath the windows along the outside wall, or from similar size acoustically lined spaces built into the cabinet work of the classroom. In either case two outlets with directional flow grilles approximately 36 in. by 5 in. supply air upward along the outside wall. The normal amount of air from an outlet is 600 cfm, the velocity averaging 500 fpm.

The special cabinets—used in the classrooms where the outlets are not built into the wood cases along the walls—were constructed by the sheet metal contractor of 16 ga material with all corners rounded so as to match the general appearance of the convection heaters installed in various parts of the building. The grilles are set flush in the top of them.

At the time of construction, the bottom of the cabinet was entirely enclosed so that the 20 in. by 8 in. opening

could be cut into it on the job to center the outlet on the window, since the spaces between the joists in all rooms did not necessarily center themselves on the windows. The interiors of these cabinets were lined with acoustical insulation and, where necessary, directional baffles were provided to distribute the air evenly from the outlet grilles in the tops. Baffles were not usually required since the cabinets serve as sound deadening plenum chambers, the resulting velocity being very uniform.

This system of distribution of the air to the classrooms is equally satisfactory whether the air is entering the room at a temperature above that being maintained or below it.

Air Circulation

The air stream is fanned along the outside wall, thereby blanketing the cold wall, and the temperature of the stream is always in accordance with the amount of heat loss from the space. By this arrangement the temperature of the primary air stream is not more than 4 or 5 deg above the room temperature when it reaches the ceiling during periods of maximum final temperatures from the booster coil.

The velocities from the outlets were carefully selected to set up enough secondary air flow in the classroom to maintain the movement in the occupancy zone at from 15 to 50 fpm, as well as to maintain small temperature differentials between the floor and ceiling. There are no down drafts along the outside walls to cause discomfort to the students, which sometimes occurs when air blows horizontally from the inside wall toward the outside wall, especially if radiation is not provided. Also, the floor temperatures throughout the room are only a degree or two below the thermostat temperature, since infiltration and down drafts from the windows are offset by the vertical stream of air.

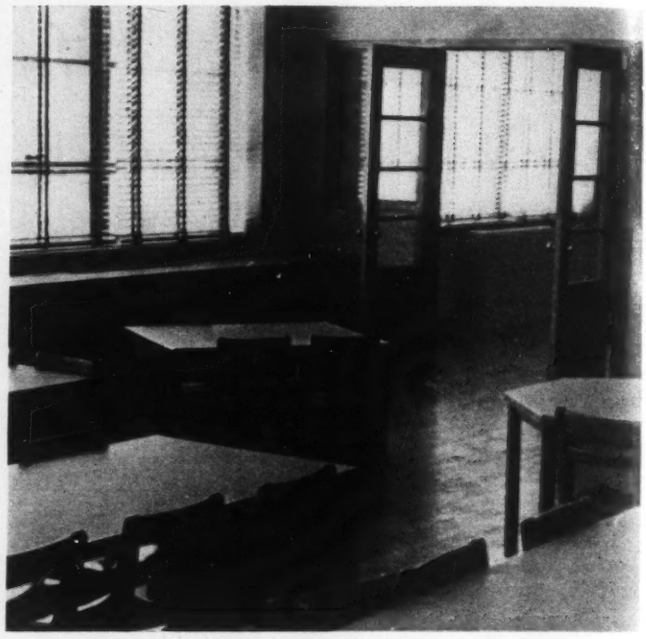
The return air, including the air that is to be vented to the outdoors, leaves the room through a recirculating grille connected by means of a short duct to the return riser extending to the main return duct beneath the building. At the point where the grille duct connects to the riser, in the space behind the lockers, is an exhaust opening to the air space between the lockers and the partition of the classroom in which is situated a balanced back draft damper that opens in relation to the amount of outside air being introduced to the classroom. Air leaves this space through vent grilles, passes into the corridors and is exhausted through rotary roof ventilators or through the toilet exhaust system.

Only the discharge and return grilles and the room controls are exposed in the classrooms, everything else in the distribution system being entirely concealed within the building construction.

The Sheet Metal Work

The installation of the sheet metal, involving about 55,000 lb, proved to be comparatively easy for the contractor, largely due to his method of procedure.

The openings for all the ducts were placed by the sheet metal contractor rather than by the general contractor, and at the same time hanger bolts were installed



One of the sheet metal cabinets may be seen through the doorway to the right and there are outlets in the cabinet work under the windows at the left. The sheet metal cabinets were built by the sheet metal contractor. At the time of construction the bottoms of the cabinets were entirely enclosed so that the required 20 in. by 8 in. openings could be cut into them on the job

in the concrete form work for all main and branch lines. There were approximately 120 openings in the first and second floor slab, and 500 or more hanger bolts.

As soon as the first floor slab was poured, complete measurements were taken of all openings as they actually existed for use in the preparation of shop drawings. Drawings were made of each main line and its branches and were carefully checked to be sure that the metal could be installed without interference with other lines or piping. These drawings were also checked with the other crafts on the job to be sure that the sheet metal could be installed as delivered without complications.

All main lines were constructed with 1 in. standing seams. All panels were cross broken to provide further rigidity. The branch ducts were made with slips and drives, with corner seams made on a lock forming machine.

Control System

Day Operation—Electric time clocks in the master control panel in the boiler room determine the hours the system shall operate on the day and night cycles. At approximately 7:00 a. m. the clocks start the fans to each zone. The outside air damper remains closed until the average temperature of the return air from the entire building has reached approximately 68 F. This heating-up period, even in coldest weather, takes a maximum of about 20 min. When the return air temperature is at its predetermined point, the outdoor air damper opens to a minimum position, regulated by positioning switches inside the master control panel. Normally the switches are set to introduce about one-third outdoor air during periods of occupancy.

The temperature of the air leaving the washer is controlled by a thermostat in the discharge which, through

a step controller, regulates the position of the mixing valve on the washer pump and of the modulating coil valve on the preheaters. If the temperature of the leaving air rises above the predetermined point, the temperature controller, through the step controller, gradually modulates the mixing valve to reduce the amount of hot water to the washer, and the preheater coil valve is modulated toward the closed position. If the discharge temperature drops, the reverse action occurs.

There is another temperature limit control behind the preheater to prevent the introduction to the washer of any outside air at freezing temperature. Also, when the hot water valve is in the closed position, calling for 100 per cent recirculation of water within the washer, the pump shuts down. If it is not possible to obtain a final temperature from the washer low enough to prevent overheating, due to high outside air temperatures, then the air washer is set up to recirculate water to provide evaporative cooling. This occurs only when the outdoor wet bulb is low enough to assure sufficient reduction of the leaving air temperature by evaporative cooling.

A humidity controller in the return air duct regulates the hot water supply to the washer in accordance with moisture requirements. In series with the humidity controller is a limit control, mounted on one of the windows not exposed to direct sunlight, which lowers the humidity setting when necessary to prevent condensation on the inside surfaces of the building.

The reheater coils in the discharge ducts from each of the four zone fans are controlled by a duct thermostat regulating the position of the face and bypass dampers to maintain a predetermined discharge temperature. Each reheater coil remains in the maximum heating position during the heating-up period. Though the average temperature of the air returned to the washer has reached its predetermined point, a minimum amount of air being admitted, the reheater coil for a particular zone may still provide maximum heating until the return air temperature from that zone is at its predetermined point. The discharge temperature from the reheaters, once the zone is within a couple of degrees of its control point, remains constant until the classrooms are up to temperature or begin to overheat.

The temperature of each individual classroom is maintained by regulation of the steam supply to the booster coil in the branch duct to each room. This phase of the system is pneumatically controlled by thermostats which regulate pilot operated valves so as to obtain true modulation. During the heating-up period the master control panel closes the air supply to the zone booster system so that the valves are wide open. The discharge temperatures from the central station to each zone never exceed the control point setting in the classrooms except during the heating-up periods, and just as soon as the average return air reaches its minimum, all final temperatures are under definite control.

Should the room temperature in any zone continue to rise after the room thermostats have closed the booster coil valves, indicating a need for cooling, the thermostat in the return from the zone compensates the controllers on the zone unit to lower the air temperature. When any zone is being compensated for lower temperatures, a controller in the zone discharge duct in turn compensates the air washer controls through the master control panel in the boiler room. During this cycle the discharge temperature from the air washer is gradually lowered so as to provide a temperature differential sufficient to prevent overheating in the zone. However, if the temperature in only one zone is rising above the control point, the reheater units on the other zones still maintain their normal discharge temperatures. If two or more zones call for cooling at the same time, the one requiring the largest temperature differential takes precedence over the others in determining the lowered control point in the washer unit. This compensation is accomplished by modulating the step controller in the master control panel.

During the day cycle, when all zones are in operation, the exhaust fans in the toilets and exhaust air dampers are automatically operated by the clock circuits on the master control panel.

Lights on the master control panel indicate the operation of the respective pieces of equipment at a glance. In addition, a light on the panel comes on in the event the filters are so dirty that the air supply to the building is decreased.

The entire panel is a dead front arrangement, there being only indicating lights and switches which can be used to turn on any one or all zones if the building is to be occupied at night.

The stokers are also regulated from the master control panel and either one or both boilers can be placed in operation therefrom.

Night Operation—At a predetermined time in the afternoon the electric clocks in the panel automatically put the heating system on night operation. Then the outside air damper is completely closed and the washer pump cut off. The fans are operated intermittently by a thermostat in each zone, maintaining a predetermined lowered night temperature. The intermittent operation of the fans does not cause the washer pump to operate nor the outside air damper to open. However, when at night one or more zones are calling for heat, which usually occurs only during very cold weather, the stokers automatically maintain a constant steam pressure in the boilers. As soon as the fans cease operation the stokers fall back on hold fire control.

At night, when the fans are maintaining a minimum temperature by intermittent operation, the exhaust fans and dampers do not operate.

In the morning at the predetermined time the clocks automatically place the system on day operation.

The central station control system is entirely electric, whereas the booster coil set-up and the individual convection heaters in the private offices are pneumatically controlled. This split arrangement is used to facilitate proper coördination of the system and for maximum economy.

The convection heaters in the toilets, corridors and storage spaces are controlled by self-contained modulating valves, which provide satisfactory regulation of temperature at minimum expense.

The architect for this school was M. B. Cleveland. Wheatland Co. was the heating contractor, and the sheet metal work was done by A. J. Schultz & Sons. The author was the consulting engineer.

[*In October, Mr. Todd described the boiler, stoker and coal handling equipment.*]

Production for the Emergency and After

Why Air Conditioning Is Essential to Efficient Defense Production Technique . . . By J. I. Lyle*

SUMMARY

The wide acceptance of air conditioning for comfort purposes has largely overshadowed the vital importance of its original and true basic services to industry and production, according to Dr. Willis H. Carrier. The condition of the air is often one of the most important elements in product processing or manufacturing. Normal air is subject to wide fluctuations which are the underlying cause of many obscure manufacturing troubles. The increased use of power, machines and illumination builds up the heat within a plant to such a point as to nullify any favorable external influences of climate that may prevail. Accuracy of predetermined results and uniformity of quantity production are possible only when atmospheric conditions are controlled. It has been demonstrated in more than 200 different kinds of industries that vagaries of weather or atmosphere can be overcome to meet the most severe specifications for precision and uniform quantity production. . . . The classified examples presented here form a condensed reference of types of production problems, the solutions of which have been accomplished or have been aided by the application of air conditioning

TODAY industrial management is of necessity paying attention to the vitally important part that air or atmosphere plays in connection with every material substance, every industrial process, and every thought and action of man. The increased use of power, machines and illumination builds up the heat within a plant to such a point as to nullify any favorable external influences of climate that may prevail. Hence, in this modern age, production plants can no longer seek geographical refuge.

The following examples are a condensed reference of types of production problems, the solutions of which have been accomplished or aided by the application of air conditioning.

Control of the Physical Reactions or Properties of Non-Hygroscopic Products

Machines, Engines, Tanks, Airplanes, High Speed Engines, Airplane Parts, Range Finders, etc.:

Precision Metal Working—In machine shops, the expansion and contraction of metals under the variations in temperature constantly experienced is greater than many of the closer essential tolerances. Engineers have designed and installed refrigeration and air conditioning for bringing castings or stock to a predetermined temperature and for maintaining the temperature of the shop constant during machining operations, thus eliminating variables with which all shops must contend.

Fine Instruments:

Master Gage Rooms—The accuracy of Johannson and other gages is such that both the calibrating and the calibrated gage must be brought to the same temperature, must be protected from dust and dirt and corrosion. Differences caused by expansion or contraction of fine gages and instruments due to atmospheric or weather variations are oftentimes greater than the allowable tolerances of the parts they are used to measure. It is obvious that unless the calibrated gage is kept at design temperature in the shop, the calibration will be destroyed.

Manufacture of Chronometers, Cameras, Range Finders, Optical Goods, etc.—In the case of the larger pieces, expansion and contraction due to normal temperature changes may exceed permissible tolerances. The finer parts must be kept free from the contamination of perspiration invisible to the naked eye. These seeds of corrosion may lie dormant for a long time before becoming active and destroying the utility of the part.

Repair and Storage—In the repair of bomb sights and variation instruments, definite control must be maintained over air temperatures and cleanliness. The storage of such metals, such as duralumin, requires a constant low temperature to prevent aging.

Communication:

Telephone Exchanges (Manual and Automatic)—The trouble and interruptions of service caused by high humidity are well known to experienced people.

Radio Tubes, Condensers, etc.—Conditions similar to those applying to watches, etc., as shown above, likewise apply to all manner of minute light bulbs and fine electrical instruments or parts. The useful life of condensers is shortened by these deposits of foreign matter.

Control of Physical Reactions or Properties of Hygroscopic Substances

Textiles:

Uniforms, Blankets, Tire Fabrics, etc.—All textile fibers are highly sensitive to humidity, the strength and uniformity of yarn depending upon the humidity under which it is spun. This is especially true of hard twisted tire fabrics and woven goods. Similar conditions apply both to the manufacture and processing of synthetic textiles.

Pharmaceuticals:

Capsules, etc.—Many of these products such as effervescent salts and capsules are highly sensitive to hu-

*President, Carrier Corp. These examples have been taken from a booklet of the same title issued last month.

midity. Others such as liver or gland extracts are critical both to temperature and humidity and cannot be made without adequate control of both.

Woods:

Fabrication—In World War No. 1 wood, not metal, was the common material used in the manufacture of airplanes. In attempting quantity production, it was soon discovered that the expansion and contraction of wood, caused by variations in humidity and temperature, precluded the adoption of methods then currently practiced in the working of metal.

Ammunition:

Time Train Fuses, High Explosives, Powder Blending, etc.—Powder is hygroscopic—that is, it will absorb or lose water to ambient air depending on humidity. More or less water in the powder alters the rate of burning.

Military Map-making, etc.:

Lithography, Map Printing, Decalcomania, etc.—Paper is highly sensitive to variations in humidity, normal large stock sheets changing as much as ⅛ in. in size under day to day variations. Accurate register in multicolor map printing or other such work is, therefore, extremely difficult or impractical without control of atmospheric conditions.

Bulletproof or Safety Glass—The adhesive with which the pieces of glass are fastened together is extremely hygroscopic and an excess of moisture with respect to the critical point prevents adhesion and leads to discoloration, impairing or destroying vision.

Control of the Rates and Limits of Chemical Reaction in Materials

Metals:

Blast Furnace—It has long been known that removal of excess moisture from the air with which the blast furnace is blown not only increases the capacity of the furnace about 15 per cent, but also permits the production of a ton of iron with about 85 per cent of the fuel otherwise required.

Nitrates:

Ammonium Nitrate—During World War No. 1 the United States had to produce large quantities of ammonium nitrate. Under the chemical processes then known, the practical method required fractional crystallization under closely controlled conditions. If carried too far, undesirable crystals were precipitated. If not carried far enough, potential production was lost.

Increased use of power, machines and illumination builds up the heat within a plant to such a point as to nullify any favorable external influences of climate that may prevail

Synthetic Products:

Rayon—In this process the spinning solution must be carefully and uniformly aged. Although the chemical reaction which causes aging proceeds slowly, it proceeds as a function of temperature. Hence, temperature and air circulation must be controlled with extreme accuracy in order to simplify the production problem into mere timing.

Nylon—is an example of new chemical developments to the production of which air conditioning is essential.

Control of Physiological Reactions for Human Efficiency, Health and Production, or in Animal Assay

Metals:

Mining of Gold and Copper—In many deep mines the humidity and to some degree the temperature in the working spaces has risen to a point almost beyond human endurance. The result in loss of production increased labor costs beyond economic limits. Air conditioning has corrected this in world famous gold and copper mines. The results are improved health of workers and increased production at the same time.

Hospitals—Operating rooms and convalescing rooms in hospitals all over the world are mute evidence of the part that air conditioning plays in surgery and post-operative care.

Improvement of Working Environment—In many industries the heat generated by power or processing equipment creates conditions approaching those existing in deep mines. Air conditioning has alleviated these conditions in lithographing on tin, in the production of small arms ammunition, and in many other industries.

Animal Assay:

Animal Assay and Experimentation—In a manner analogous to the condition existing in machine shops with relation to parts tolerances, variations in the physiological reactions of animals to normal atmospheric temperature changes exceed the limitations of the experiment. Hence, without air conditioning, reliable results would be impossible in summer weather, and all work would have to cease until more favorable conditions existed.

Unhealthy or Harsh Climates—With human endurance, physical energy, and morale always directly dependent on given minimums of healthful sleep or rest, air conditioning successfully combats unhealthy or harsh climates in every kind of human habitation ranging from those of workers in the deep jungles to habitations above the Arctic Circle.

Control of Biological or Bacteriological Reactions

Food:

Food and Food Products Manufacture, Preservation and Transportation—Decay and spoilage of meats is largely due to the influence of bacteria and mold, the reactions of both being highly sensitive to humidity as well as to temperature.

Fermentation—The propagation of mold spore in the process of fermentation is in all cases sensitive to temperature, and in most cases sensitive to humidity. About 30 more loaves of bread may be obtained from a barrel of flour if fermentation is carried out under controlled atmospheric conditions.

Pests:

Pest Research and Control—The reproduction cycle of pests such as the grasshopper, the tsetse fly and others has been speeded up by air conditioning so that five or more generations could be produced in a single year. The production of benign insects to be released for the destruction of the harmful ones has likewise been increased by air conditioning. Similar results have been accomplished in plant life also.

Units Using Diesel Cooling Water Heat Plant

By Francis A. Westbrook

When the Rockford Screw Products Co., Rockford, Ill., installed diesel engines for generating electrical power it went a step further and made provision for utilizing the otherwise wasted heat in the cooling water of the engines for heating its plant.

There are two 210 hp and two 300 hp diesel engines driving electrical generating units. In addition there is a six cylinder, four cycle auxiliary diesel generating unit to supply power and lighting during shutdown periods. The plant operates on three 8 hr shifts for six days per week. Under these conditions there is sufficient heat in the engine cooling water to heat the plant during the coldest winter weather. To accomplish this six unit heaters were installed in the building and the engine cooling water is circulated through them by a pump. Each heater is equipped with a motor driven fan which runs all the time.

An interesting feature is that each of the unit heaters is provided with two thermostatically controlled louvers. One louver opens to the atmosphere and the other into the room. The thermostats are set so as to open the louvers into the plant when the inside temperature drops to 68 deg, and at the same time to close the other louvers. When the room temperature reaches 70 deg the reverse operation takes place so that the air heated by the cooling water is discharged outside. In very cold weather all of the heat extracted from the cooling water is used to heat the plant. In summer none of it is used. The temperature of the cooling water must be reduced regardless of the weather, so the fans on the unit heaters must be in constant operation, and the amount of heat utilized is controlled by the thermostatic operation of the two sets of louvers. In either case ventilation is provided for the shop.

When the plant is closed down on Sundays the small amount of heat needed is supplied by three small oil-fired boilers. The small 60 hp diesel generating unit supplies the necessary power for operating the unit heater fans, circulating pump and lights.

Circulating Piping Systems Promote Efficiency in Industrial Finishing

Paint Circulating System Used in Many Industries Described by L. J. McGrady*

IN THE automobile plants and in other industries where large quantities of finishing materials are used daily, you often find today that the paint containers which once stood beside the operators at each booth or spray station have disappeared. Paints, undercoats, surfacers, etc., now reach the operators through pipe lines. There are no containers to clutter up the booths, floor space is conserved, and housekeeping conditions in general are improved. Trucking of material from the mixing room to spray booths and the hazards of frequently filling a large number of tanks are all eliminated.

These improvements make for better working conditions, but they are not the only advantages of the paint circulating system. Off-color troubles are eliminated by reason of the quantity mixed, and the method of mixing and agitating used. Responsibility for uniform material viscosity is placed in the hands of one man—the one in charge of the mixing room. Any tendency of operators to interfere with the paint mixture to suit their convenience is obviated. Loss of paints and solvents due to evaporation, spilling, etc., is reduced to a minimum. A clean, thoroughly mixed supply of material is assured through the constant filtering and circulation. There is no delay for filling in the midst of spraying operations as frequently happens when someone forgets to check material on hand. Uniform fluid pressures are maintained by fluid regulators at each spray station, all set and adjusted by a master key held by the paint foreman. Roughness, orange peel, improper drying and other finish difficulties are reduced through more rigid control.

How are all these advantages accomplished? How does a paint circulating system operate?

Let's start with the mixing room, where we find two rows of tanks which may be of 30, 60 or 120 gal capacity. In the one row are mixing tanks and in the other circulating tanks. All are equipped with explosionproof, geared head motors mounted on the top and connected to two bladed agitators. A portion of the cover is hinged, and made vapor tight by means of a special gasket. This hinged portion of the cover provides a generous opening for quick and easy filling.

In this same room, unless prohibited by local regulations, is a row of pumps—one for each set of tanks. The pumps are driven by explosionproof motors and controlled by explosionproof pushbuttons conveniently situated near the mixing tanks.

Bulk finishing materials are brought into the mixing room, usually by overhead crane, and dumped into the mixing tanks. Solvent, which is piped into the room and measured by a flow meter, is added as required. Material and solvent are mixed until proper spraying viscosity is obtained. The time varies, of course, depending upon the original consistency of the material and how much it is to be mixed or reduced.

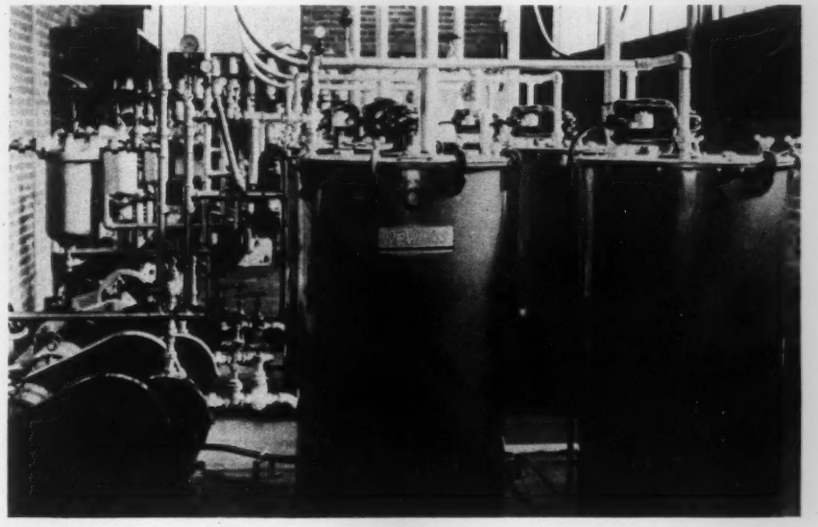


Fig. 1—Typical mixing room showing circulating and mixing tanks, pumps, and filters

The properly mixed material is pumped into the circulating tanks, and from there through pipe lines to all the spray stations. The material travels in one direction to each spray station until the last one is reached. From this point it takes the shortest route back to the mixing room, thus making a continuous circuit or loop. On its return to the mixing room the material enters the circu-

SUMMARY

In many automobile plants and in other industries using large quantities of finishing materials, paints, undercoats, surfacers, etc., now reach the operators through pipe lines from central mixing rooms. By using "industry's greatest transportation system"—piping—for this service, working conditions are often improved and production problems simplified. . . . Mixing and circulating tanks, motor driven agitators and pumps (where local regulations permit) are installed in the mixing room. The properly mixed material is pumped into the circulating tanks and from there through pipe lines to all the spray stations, making a continuous circuit or loop. . . . Material lines are usually ¾ in. or 1 in. galvanized pipe, all bends are long radius with a minimum radius of 12 in. A small installation may have one or two circulating pipe lines and a large one may have 10 or more

*The DeVilbiss Co.

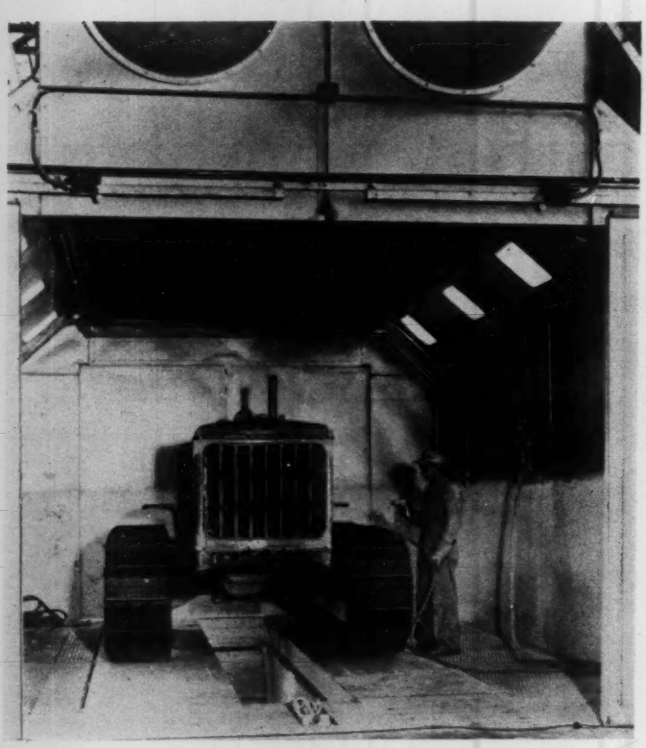


Fig. 2—A three line system in a tractor plant

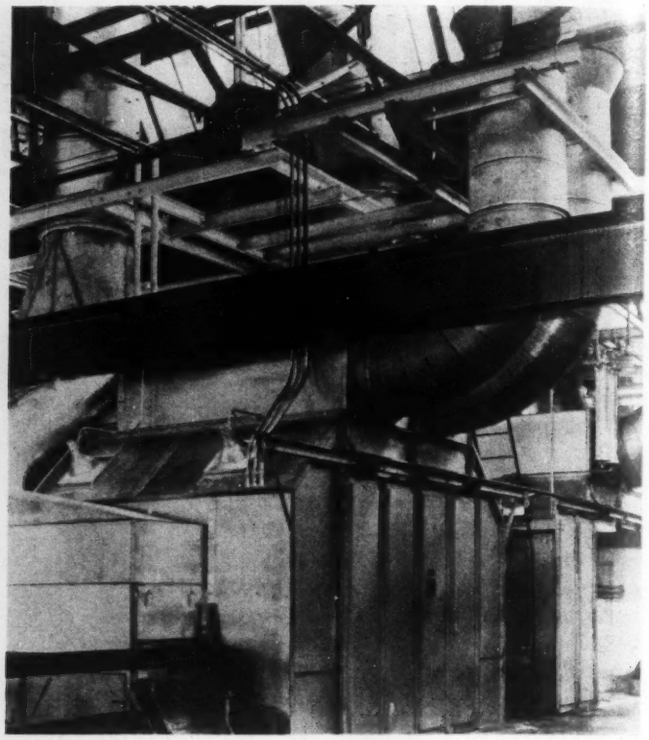


Fig. 4—Pipe lines entering the spray booth shown in Fig. 2

lating tank, allowing the mixing tank to be emptied. The new batch is then begun in the mixing tank so it will be ready for circulation as the previous batch is used from the circulating tank.

A safety valve installed in the line between the pump and circulating tank relieves any excessive pressure that may occur due to dirty lines, clogged filters, etc. Should such a condition occur, it automatically opens and bypasses excess material from the discharge side of the pump back into the tank, or in other words, to the suction side of the pump.

There is a mixing tank, circulating tank, pump and pipe line for every color or different material. The system may have any number of lines depending, of course, upon how many colors or different materials are to be circulated at one time. A small installation may have only one or two lines and a large system may have 10 or more lines.

At each spray station there is a fluid regulator on each line which independently controls the fluid pressure for the operators. These valves can be adjusted and set by a master key held by the foreman. Such an arrangement eliminates meddling or tinkering with the adjustment by the operators. Hence, finishing material is delivered to the spray guns at a uniform pressure, insuring even application in the proper thickness, thus lessening sanding and polishing operations.

Material lines are usually galvanized pipe, either ¾ in. or 1 in. in diameter, depending upon the length of the line, viscosity of materials and number of guns to be

Fig. 3—Illustrating the wide radius bends and staggered regulators in a 10 line circulating system

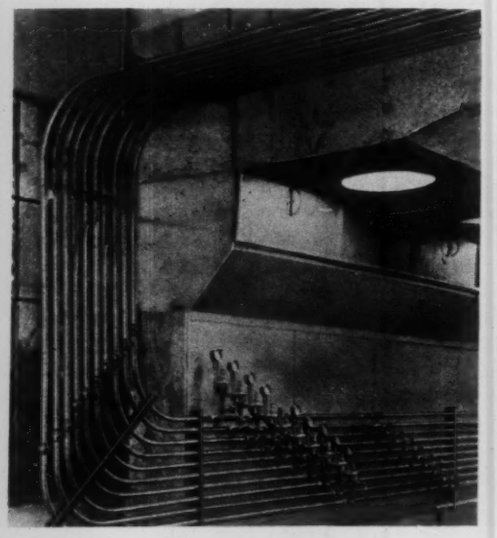
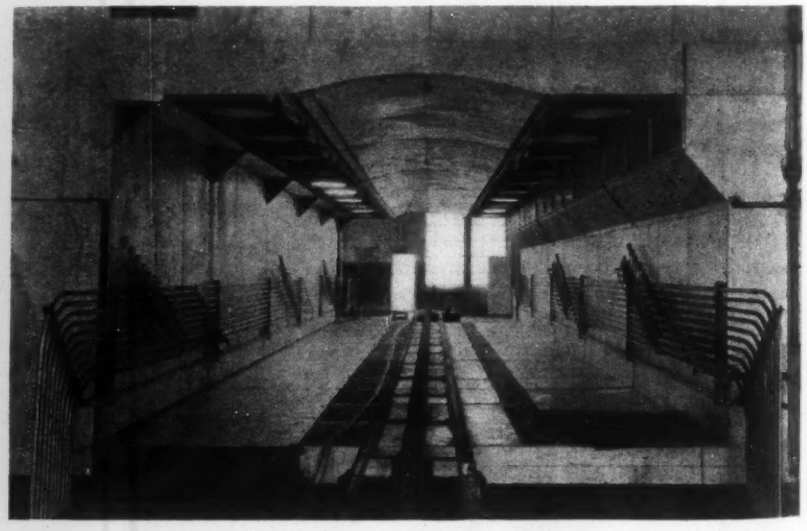


Fig. 5—Spray stations in a large automotive plant



supplied. All bends in the lines are of the long radius type with a minimum radius of 12 in. The pipe lines may be run along the ceiling with drops at the spray stations or along the ceiling below with stubs through the floor at the proper locations.

The finishing material is circulated constantly during the working hours and is continued during the night at a reduced pressure. When a gun is not in use, material is circulated through the hose by means of a "tie-back." In this arrangement the hose is removed from the gun and attached to a Y fitting in the line beyond the regulator. Material then circulates through the hose as in normal operation.

The pressure feed container is still to be recommended and is still satisfactory for many plants, especially the smaller ones, where quantity or varieties of materials exclude the use of the paint circulating system. For the larger plants, however, the advantages of this system should not be overlooked. Considering the possibilities of better working conditions, less interruptions, savings of material and improved finishes, a circulating system will often pay for itself in a surprisingly short time.

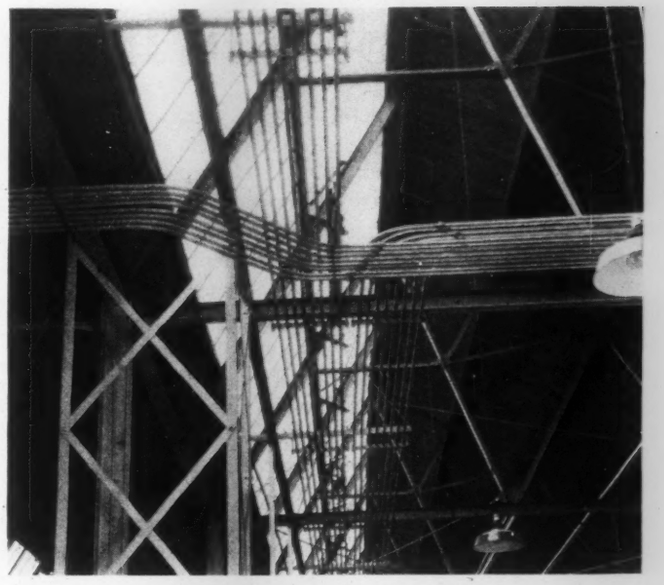


Fig. 6—Pipe lines installed along the ceiling. Note the long radius bends

Water Consumption in Hotels

The American Hotel Association 221 W. 57th St., New York, N. Y., has published a 32 p., 7¼ x 10½ in., paper covered booklet on water consumption in hotels. It was written by Georges C. St. Laurent, Wegg and St. Laurent, hotel consultants, engineering consultant and advisor to the AHA national membership division. Price is $1.00.

Mr. St. Laurent says that the cost of water to hotels is on the increase, due partly to air conditioning equipment without water reclaiming facilities and partly to the fact that many local municipalities have not only raised their base rates but have established sewage disposal plants which are being paid for by water consumers of the municipality in direct proportion to water consumed. It is of increasing importance to know where and how the water is consumed, to compare water consumption with hotels of similar size and types and to devise ways and means of cutting down consumption.

Unless means are provided for re-using condenser cooling water over and over again, the hotel's water consumption may be practically doubled with a large air conditioning installation, Mr. St. Laurent says. For certain types of air conditioning equipment, evaporative condensers can be installed that will save about 90 per cent of the cooling water for re-use. Evaporative condensers are easy to install, highly efficient, require very little piping, are not noisy, and can be installed in a very small space in the basement or some other convenient location. The cooling tower, which is usually situated on the roof, is suitable for very large installations as well as small and can be used for any type of installation.

There are other ways in which this cooling water can be utilized by the hotel if evaporative condensers or a cooling tower are not available.

Some hotels discharge the cooling water into an open surge tank in the basement from which it is pumped to the roof tank for use throughout the building. This is not always feasible where the water supply is provided by a closed pressure system with no roof tank. Also, it may not be possible to discharge the cooling water into the house supply tank on the roof because of local plumbing ordinances which prevent this practice. In some instances, only a part of the cooling water can be re-used for the house supply due to the fact that the cooling water, after it has been used by the air conditioning equipment, is warm and may raise the temperature of the house cold water supply too high for guest purposes.

Some hotels use their air conditioning cooling water for jacketing purposes in the engine room or for boiler make-up feedwater supply. It may also be utilized for hydraulic elevator operation, watering lawns of adjoining grounds, washing cars in the hotel garage or in the laundry.

Many hotels are now supplying their air conditioning and central refrigeration plants with well water, even though such well water may not be suitable for general hotel use. Well water is usually much colder, especially during the summer months, than the water obtained from other sources and is highly desirable for this purpose.

In connection with boiler room and engineering department water consumption, the report points out that water may be wasted by deteriorated water pipes in unexcavated sections, deteriorated cylinders and valve equipment for hydraulic elevators, leaky blowdown valves, feedwater heaters of insufficient capacity which may cause loss of hot condensate to the sewer, excessive amounts of cooling water introduced into the suction side of vacuum pumps, steam traps in poor repair or discharging to sewers, etc. Storage tanks in the basement should be carefully checked once a year so that any leakage directly into the ground will be discovered, says the report.

Stored Steam Increases Plant Capacity

THERE is an erroneous though common belief that the only economic justification for superheaters, economizers, steam storage systems, and similar auxiliaries is the increased efficiency obtained. Actually, there are many important applications for increasing capacity or power of existing equipment—entirely independent of efficiency. The action of the added auxiliary is often that of a "booster" providing the necessary increase to meet new plant conditions. Results have been outstanding, earnings increased or costs reduced, as required, with materially improved operations.

In instances of heavy load swings imposing severe peaks in boiler plant output, the need is for heat storage to act as a "thermal flywheel," furnishing either steam or feedwater to make up the deficiency caused by a short but sudden peak demand. Steam accumulators for this purpose have been installed in the United States with capacities as high as 60,000 lb and as low as 440 lb. The former is in a large sugar refinery where evaporators develop large peak demands for low pressure steam; the latter is in service at a prominent Pennsylvania coal mine where fluctuations are produced by the engines operating a pair of hoists hauling loaded mine cars to the surface.

Reprinted by permission from Heat Engineering, a publication issued by Foster Wheeler Corp.

The operating cycle for one engine is made up of—

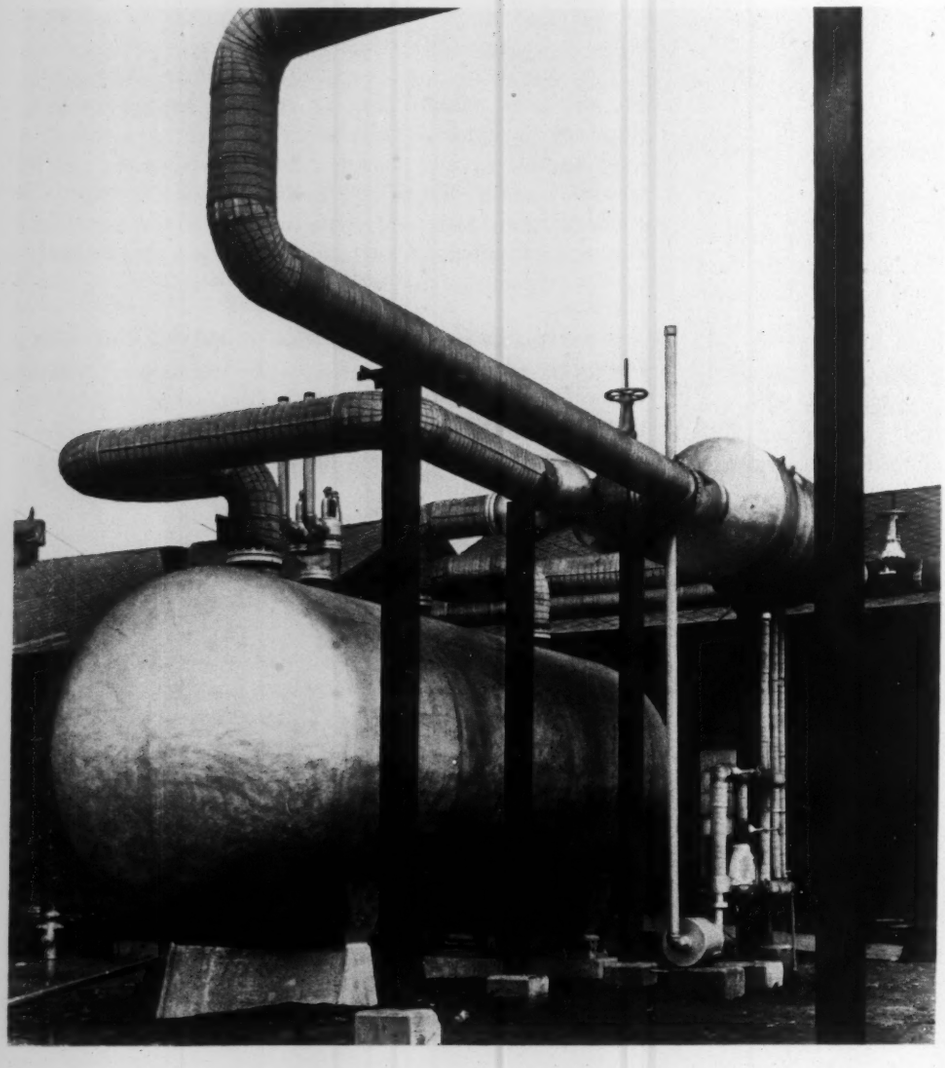
1) An acceleration period of about 9 sec, during which the hoist is brought up to speed and when the engine steam demand may reach a rate of about 75,000 lb per hr.

2) A constant speed period of about 10 sec, when the engine steam demand is reduced to a rate of about 33,000 lb per hr.

3) A decelerating period of about 17 sec, while the hoist is brought to the landing and the cars changed. No steam flows to the hoist engine during this period.

Both engines operate independently and on about the same cycle, without synchronization. It is possible, therefore, that both engines may be started simultaneously, several times an hour, which creates a steam demand at a rate of approximately 150,000 lb per hr. The long pipe line between the boiler house and engines is large enough to permit satisfactory operation of the engines but such operation imposes severe peaks on the boilers. However, with the installation of the steam accumulator, adjacent to the engine house, the peak steam demands are furnished by the accumulator instead of directly from the boiler plant.

The steam accumulator for this service is a welded steel vessel about 10 ft in diameter and 30 ft long. Steam stored at 128 lb per sq in. pressure is discharged at a minimum of 100 lb pressure. The capacity of 440 lb of steam is sufficient to balance the peaks produced by the hoist engines. At times when the engines make no demand, steam flows from the boilers into the accumulator and is stored in readiness for the next peak. By operating the boilers at more nearly constant rating, it is possible to reduce maintenance costs and improve boiler efficiency.



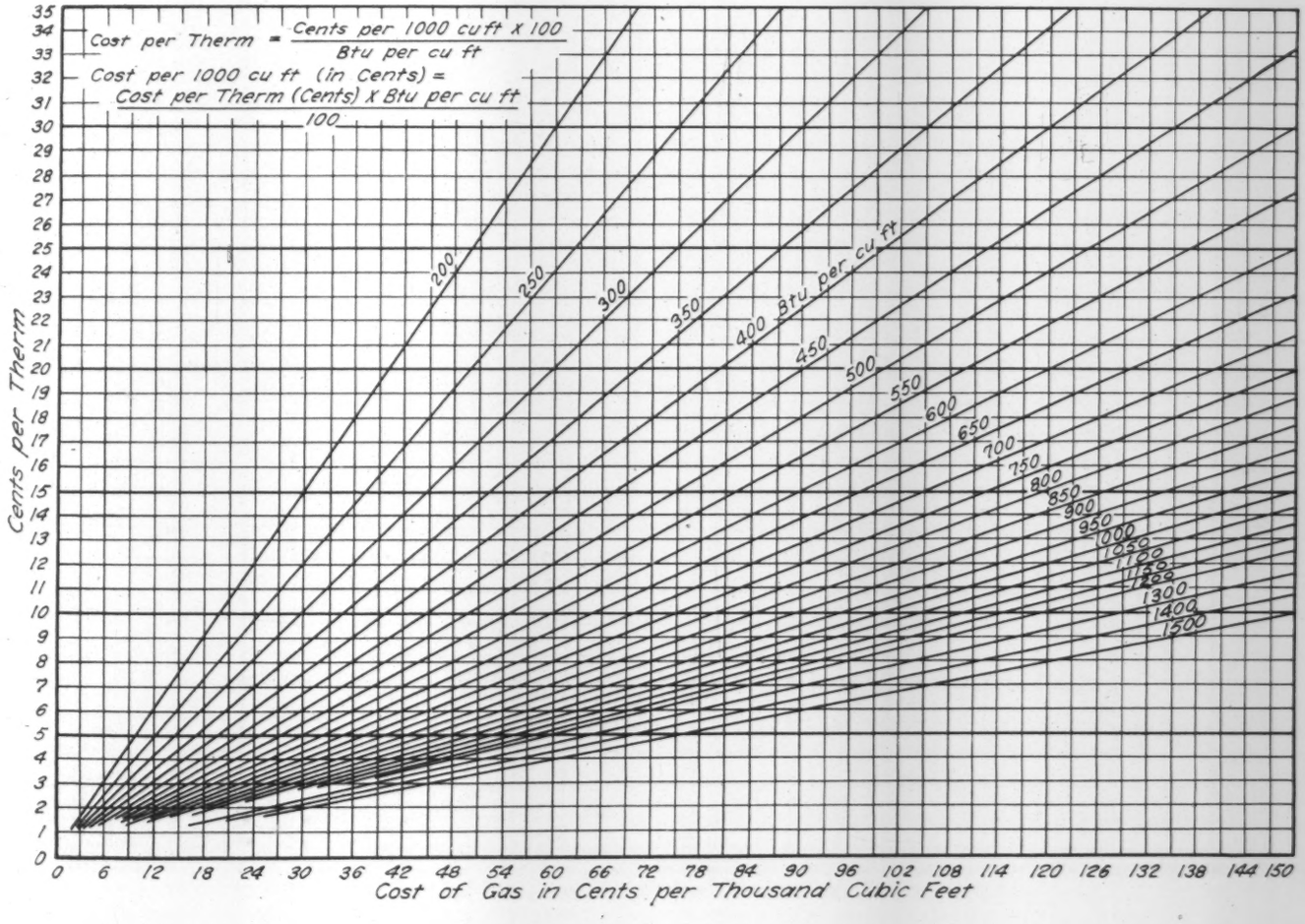
Close-up of steam accumulator showing method of support with rollers under the far end to permit expansion. Steam enters at the center; when required, it leaves at both ends through expansion loops. The steam separator in the line at the right removes water and reduces effect of engine pulsations

Cost of Steam With Gas as Fuel

Charts Prepared by Irving E. Brooke, Consulting Engineer, Give Complete Data for Easily Computing the Cost of Fuel

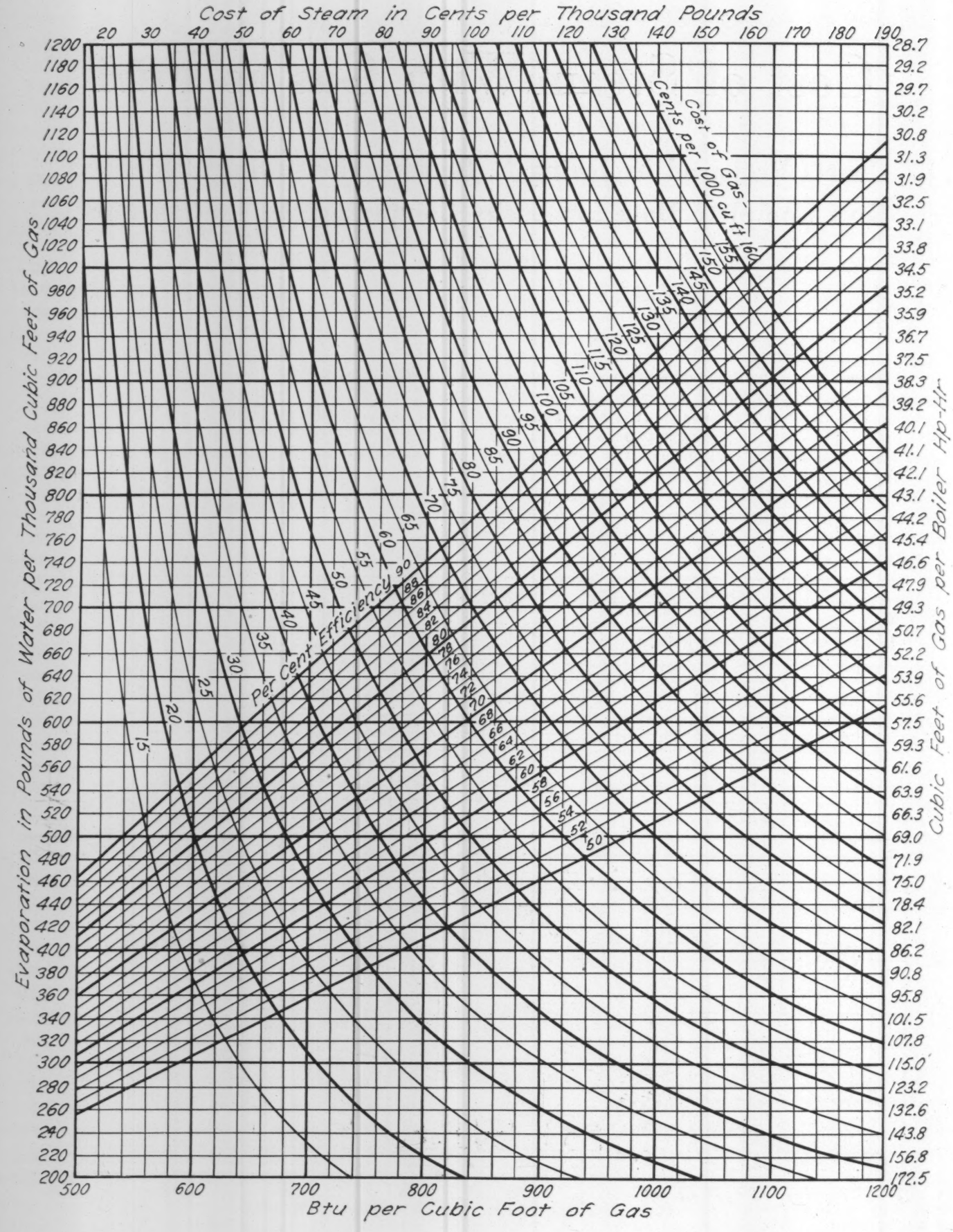
A FEATURE of these charts for determining the cost of steam using coal, oil or gas as the fuel is that they can be used if either the per cent efficiency, evaporation in lb of water per unit quantity of fuel, or unit quantity of fuel per boiler hp-hr is known. The coal chart was published in September, the oil chart appeared last month and the gas chart is shown on the next page. The chart on the next page is used in the same manner as are the coal and oil charts, which use was fully explained in the September and October issues of HPAC. Briefly, the chart is entered at the proper point on the bottom scale. From there, go vertically until either the per cent efficiency, evaporation in lb of water per 1000 cu ft of gas, or cu ft of gas per boiler hp-hr is intersected. Then go horizontally to right or left until the proper cost curve is intersected. From this point go vertically to the top and read the cost of steam in cents per 1000 lb.

For use with the gas chart, there is also a supplementary chart—reproduced below—for quickly comparing gas costs either on the basis of the cost per therm (a therm is 100,000 Btu) or the cost per 1000 cu ft of gas of various Btu values. Use of this chart is self-evident.



Cost of Steam Using Gas as Fuel

[*See instructions for use on preceding page*]



Heating-Piping-Air Conditioning

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

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At the October meeting of the Council the schedule of initiation fees and dues for 1941 was approved as follows: *Initiation fees* for Members and Associates $10 — Juniors $5. *Annual dues* for Members and Associates $18 — Juniors $10 and Students $3 (with privilege of purchasing THE GUIDE at special member rate).

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The complete edition of THE GUIDE 1940 — 10,600 copies—has been distributed.

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Vol. 45, 1939 TRANSACTIONS have been sent to all members eligible. This volume contains 718 pages of papers and discussions, as well as the proceedings of three Meetings of the Society held in 1939.

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Texas Climate vs Human Comfort

By Howard E. Degler* (*MEMBER*)

DURING the months of July and August, 1940, in Schenectady, N. Y., the author found that cooling of buildings for human comfort occupancy was required on less than 10 days. No doubt other northern cities such as Washington, Pittsburgh, Cincinnati, and St. Louis had 25 to 40 summer days that necessitated indoor cooling for continued human comfort during the summer months of 1940. However, in the state of Texas there are approximately 100 summer days annually that require some cooling for continued indoor comfort; also there are about 100 winter days that require some heat. Hence during an average year, one-third of the days require some indoor heating, one-third require some indoor cooling and one-third of the days require no heating or cooling for human comfort.

Uncertain Texas Weather

More than 60 per cent of the dwellings in the northern cities of the U.S.A. have central heating plants for winter indoor comfort, whereas less than 5 per cent of the homes in Texas cities are similarly equipped, despite the fact that 75 per cent of this state experiences subfreezing winter temperatures annually and 33 per cent of the state encounters sub-zero temperatures, occasionally, as well as frequent north winds. Summer dry-bulb temperatures of 95 to 100 F with 10 to 12 hours of bright sunshine are frequent in all parts of Texas but the accompanying relative humidity varies greatly throughout this vast area at any one given time and with considerable seasonal variation for any given city.

In most parts of Texas, especially in the southern half, night temperatures are considerably less than daytime temperatures throughout the summer months; this differential frequently being 25 to 35 F. It has frequently been said that "No one but a fool or a newcomer will predict Texas' weather" and this is true for any time of the year, but particularly during the months of September and October when temperatures vary considerably, with no annual regularity, and changes are so abrupt that occasionally a "norther" will reduce the temperature from 85 to 45 F within a few hours. Truly, Texas does have unusual, variable, and unpredictable weather.

Criterion for Human Comfort

The ultimate objective in the development of any heating or cooling device is to make human beings comfortable. Therefore, we are not interested essentially in temperature, humidity, air motion, dust and bacteria counts, and other indices of air conditioning, but in human comfort. Human comfort is an elusive thing to measure and to specify, as well as to achieve; it means one thing for you and another for me. But for all of us, and this is an unfailing criterion, human comfort is successfully accomplished when a person is unconscious of the necessity of any physiological adjustment to the environment, atmospheric or otherwise. The proper function of a heating or cooling plant is, therefore, not to heat or cool the human body, but to continuously produce an atmosphere wherein a person loses an amount of heat corresponding to that generated, without any conscious bodily adjustments having been made. In order to maintain a constant temperature of 98.6 F, the rate of heat dissipation from the human body must exactly equal the rate of heat production within the body.

Building Construction

The maintenance of human comfort requires a proper atmospheric environment and a proper physical (structural) environment, both of which must be agreeable to the occupants. The former depends largely on the heating or cooling equipment, while the latter depends on the structure or building surrounding the occupants who are to be made comfortable. Much progress has been made and great interest has been shown in the equipment and its controls, but Texas building construction frequently considers only its mild climate and hence may not be suitable for all year round air-conditioning. Building construction is fully as important as the equipment, and may completely determine the type, size, and operating cycle of the equipment, as well as the first cost and operating charges. Greater public desire for improved human comfort will increase the demand for better building construction and the more common usage of insulation for old and new buildings.

Selection of Equipment

When an engineer makes a study of air conditioning needs in Texas the many considerations previously mentioned and discussed must be kept in mind as no standardized piece of equipment will give the best results under such varied conditions. Only by designing air conditioning equipment to meet the climatic conditions in each locality is it possible to get the best results at minimum expense for installation and economical operation. It is generally agreed that basic design conditions for Amarillo, Wichita Falls, El Paso, and Del Rio are greatly different from those for Galveston, Houston, Corpus Christi, and Beaumont. The North and West Texas group could profitably use evaporative cooling equipment; for the Gulf Coast cities, mechanical (compressor) systems are required for continuous comfort control. Partial cooling may be obtained during the night with attic fan installations, which are especially adaptable for residence use in many parts of Texas.

Air Filtration Essential

The removal of dusts and pollens by filtering may constitute a very real advantage in some localities in Texas, or for some persons. The occasional dust storms in North and West Texas, the pollens from Johnson and Bermuda grasses, from tumbleweed and ragweed, as well

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as the pollen from the mountain cedar trees, are known to be the cause of a half-million annual cases of hayfever in the state of Texas. Hayfever generally occurs in three seasons, according to the flowering of the three classes of plants that cause it. During the winter and spring, hayfever may be caused by the pollen from trees, during the early summer by grasses, and in the late summer months by weeds. Hayfever symptoms can be relieved most logically by removing the cause; controlled vegetation and an application of the principles of land conservation would help considerably in reducing the amount of dust from wind storms and pollen produced by trees, grasses, and weeds. Air filtration that removes all but traces of dust and pollen will relieve the symptoms of hayfever. In addition to pollen concentrations, weather changes are important influences in precipitating attacks of hayfever in sensitive patients. Hayfever can be relieved by air-conditioning methods which can be varied to meet seasonal requirements. Thus suitable air conditioning units can provide a possible means of relief to thousands of Texas citizens who are now suffering with seasonal dust-and-pollen hayfever and its distressing effects on the human body[1].

Quality of Installations

The standard of work of some air conditioning installations in Texas has been high but misrepresentations and much cheap second-rate work has been carried out and in many cases the term "air conditioning" has fallen into disrepute as a result. Some months ago Texas newspapers quoted me as saying, "Blowing air across a wetted rag is not air conditioning;" the reporter had caught the idea after being told that a San Antonio drug store was selling a so-called air conditioning unit for $4.95 which consisted of a small desk-fan blowing air across five wicks dipping into a small rectangular pan of water. Another extreme misrepresentation is the case of a house-to-house salesman calling at my home and offering a tank type of vacuum cleaner as an air conditioning unit.

The need for air conditioning in Texas is such that all of the possible equipment combinations and parts thereof have been tried during the past 10 years with uncertain success and at considerable expense to the public and with doubtful value to the industry. What the air conditioning industry needs in Texas is trained engineers and technicians, and fewer smooth-tongued salesmen who have entered this promising field because of unemployment in other pursuits.

The above difficulties may be considered as inevitable in any fast-growing industry, but the possibilities of expansion in the state of Texas are dependent upon better installations and a larger number of satisfied users. A rational program for improving and expanding the air conditioning industry is by education; education of the public, education of the architect, education of the medical profession, and education of the engineers and technicians. The formation of comfort cooling codes and specifications should help considerably to improve matters in this respect.

Recent installation features are the use of higher inlet (into cooled space) air velocities with draftless diffusers, and the improved quality and more comprehensive use of automatic controls. In connection with the latter the modulating type of control for varying the outside to inside wet-bulb (or effective) temperature differential for summer cooling is a more reasonable basis of design and a vast improvement over the older idea of a fixed inside temperature irrespective of outside conditions. As we are living in a noisy and nervous world, the designing engineer must provide for the reduction of noise and vibration to assure greater human comfort.

Automatic Controls Necessary

Only with a good control system is it possible to obtain the maximum performance from any heating, ventilating, cooling, or air conditioning system. Many Texas installations are manually controlled to save cost and operating expense; hence they are generally unsatisfactory and are not a credit to the industry. An automobile cannot be used without a driver; someone must be at the wheel to control the power of its engine. Someone with steady nerves must steer the vehicle in and out of traffic, also apply his foot to the brake or accelerator, switch on lights, touch horn, etc. In other words, the vehicle must be controlled, otherwise it will run amuck. Without control, the automobile becomes a bucking broncho and a destructive force; with control, it is an obedient wheel horse ready to serve its owner.

A heating, ventilating, cooling, or air conditioning installation cannot be allowed to operate uncontrolled and be expected to give satisfactory results. Uncontrolled air conditioning is probably worse than no air conditioning at all. If all driving were done on straight concrete roads at 30 mph with no cars in sight, controlling an automobile would be easy. The same holds true for the air conditioning installation; if all control problems were the same, the answer would be very simple. There are a host of variables affecting the selection of controls. The most important are: (1) climatic requirements, (2) individual requirements, and (3) load factor.

Weather data collected for any one year for the Texas cities mentioned earlier in this discussion would show the uncertainty of Texas weather and would indicate the difficulty of laying out a control system to combat climatic changes. The variable of climate is probably the most difficult to control of the three mentioned because of the constantly changing outdoor conditions. Every home and office has a fresh air addict who frequently opens the windows, and his opposite who closes the windows as fast as they are opened. Why? Because each has his own individual comfort requirements. Have you ever asked yourself, "What is perfect weather?" There are as many answers as there are people in the world. Yet the control system must create, as nearly as possible, "perfect weather."

The load factor is the most variable of the three mentioned; it is the percentage of actual use to full load capacity. For instance, an air conditioning system is designed to meet maximum conditions; but the sun doesn't shine all day or every day, nor is a restaurant crowded every hour, nor is every piece of heat producing equipment in a beauty parlor used continuously; nor does a

[1] "Air Conditioning for the Relief of Cedar-Pollen Hayfever," by Willis and Degler. Bulletin 31, Bureau of Engineering Research, The University of Texas, 1939. (Available upon request.)

department store burn all of its lights all of the time, etc. Consequently a control system is necessary to regulate these variables in order to conserve power and maintain perfect human comfort.

Ventilation Requirements

Few people give any consideration to the air which surrounds them; it is accepted as one of the few remaining free necessities of life. A few pounds of food and water are taken into the human system daily; regulations governing the production, distribution, and preparation of food and water are given considerable attention in order to conserve public health. But a person takes over 25 lb of air per day into the respiratory tract, which contains the most sensitive organs of the body. Also, the human body is continuously surrounded by this same air, which in a large measure controls the rate of heat production in and dissipation from the body. From this viewpoint, the atmospheric surroundings, which are taken so much for granted, become of great importance, and more attention to the factors affecting the purity and satisfactory condition of the air should result in greater human comfort, improved health, and a longer span of human life.

In the state of Texas there are no laws designating the ventilation requirements of any occupied space, hence little attention is given to this important health item to foster purer air. It costs money to condition air, hence there is a tendency to reduce the outside (ventilation) air to a minimum. The exact amount of outside air required in a given space depends upon the cleanliness of the occupants, the temperature maintained, and the degree of freedom from odors desired. Some years ago, when carbon dioxide was considered to be the determining factor, some states enforced laws requiring 30 cu ft of outside air per person per minute in schoolrooms. Additional knowledge has in recent years reduced this requirement to 10 to 15 cfm, the chief consideration being that air for human occupancy should be refreshing and free from any obnoxious odors or harmful substances.

Value of Specifications

The time honored and practical method of writing specifications and calling for competitive bids thereon, with complete statements of the performance guaranteed, is the best plan to obtain accurate and competitive cost data for the solution of a given Texas heating or cooling problem. If costs are stated by divisions, such as for insulation, for combined heating and cooling system, etc., with the right reserved to accept any one, or any group, or all of the separate bids, the greatest flexibility will result. Those sections may then be selected which come within the budgeted amount. If only the insulation and a heating system are originally installed, then the possibility remains of obtaining correlated additions later.

In Texas as elsewhere, the question will inevitably arise as to whether or not the lowest of competitive bids on perhaps the poorest equipment should be accepted, or whether a better quality of equipment should be selected at a higher price. In this regard, it may be difficult to frame any better statement of a general nature than the oft-quoted observation of John Ruskin who said, "There is hardly anything in the world that some man cannot make a little worse and sell a little cheaper, and the people who consider price only are this man's lawful prey."

Progress by Satisfaction

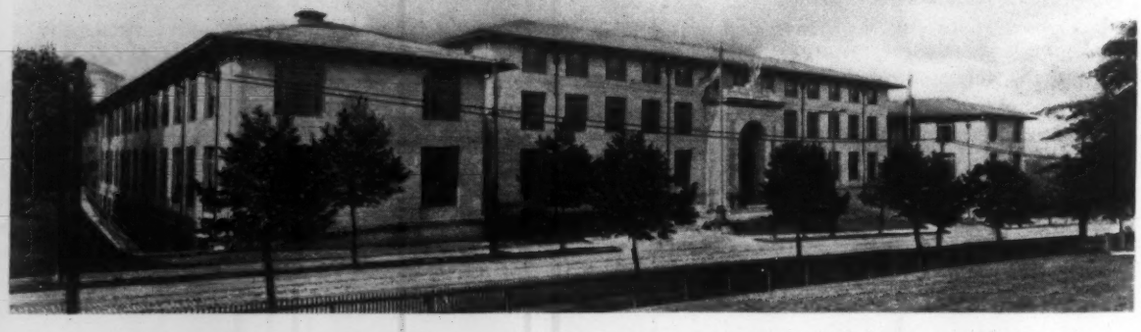
A thorough analysis of an industry as diverse in its scope and its interpretation by the public as that of air conditioning necessitates a more complete understanding of this subject. True air conditioning should provide more than simply cooling or heating, or even both; it should provide all-year round human comfort. In summer, the conditioned air must be cooled, dehumidified, circulated, and filtered. In winter, the air must be humidified and heated as well as filtered and circulated.

The American public must be enlightened to realize that true air conditioning is based on engineering skill which solves individual problems with proper equipment and that satisfactory results are not obtainable with many of the home-made, mediocre, makeshift, uncontrolled, partially effective, noisy, drafty, unsightly, and improperly installed equipment now being sold to gullible persons by uninformed salesmen. The novelty of the subject to the general public and the conflicting claims made for different types of air conditioning apparatus have resulted in much confusion and misconception of the meaning of the term. In many cases this has contributed toward dissatisfied users, with the accompanying effect of retarding the advancement of the industry. Progress can be made only by the complete and continued satisfaction of all persons who experience the real comfort of true air conditioning.

Conclusion

As mentioned previously, the weather in Texas is extremely uncertain from year to year, season to season, week to week, day to day, and even from hour to hour. During the winter months (Nov. 15 to March 15), there are occasional periods when the outdoor temperature may go above 80 F on successive days; and during the summer months (June 1 to Sept. 30), outside temperatures may drop to 45 F in Central and North Texas. Because of these extreme variations the comfort zone for Texans is in the upper region or beyond the high limit of the comfort charts (summer and winter) as now published by the ASHVE, especially during the heating season. Accordingly, Texas air conditioning engineers are continuously confronted with the changeable and unpredictable weather as well as the uncertainties of man's physiological desires and his individual opinions of what constitutes human comfort. The coordination of these two items (weather and comfort) must receive greater future consideration and correlation if air conditioning in Texas is to be universally accepted.

It is the duty of the engineer, the architect, and the manufacturer to inform the prospective purchaser of air conditioning not only of its possibilities but also of its limitations. By a better understanding between all parties concerned of the various correlated factors, air conditioning will progress more rapidly, and become a better understood and a more appreciated branch of science. There is no doubt of the widening scope of opportunities ahead in the state of Texas.



Pittsburgh Experiment Station of the U. S. Bureau of Mines where the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS is located

Sensation of Warmth as Affected by the Color of the Environment

By F. C. Houghten* (*MEMBER*), H. T. Olson,** and John Suciu, Jr.***
Pittsburgh, Pa.

THERE is an accepted belief that a person's sensation of warmth may be affected by color. For instance, an individual is presumed to feel warmer in an environment finished in a color scheme in which red predominates, as compared with one in which blue is the prevailing color. A great deal of discussion has resulted from this subject involving such phases as whether the effect is purely psychological or whether the psychological effect actually influences the person's physiological reactions to the extent that changes in feeling of warmth result, due to variations in metabolic rates of heat production.

This is obviously an important question in connection with the control of the warmth-giving factors in a person's atmospheric environment, or, in other words, it is important to the heating, ventilating and air conditioning engineer. Recently the problem has received increased attention through the combined interests of the air conditioning engineer, the illuminating engineer, and those interested in painting or in otherwise controlling the color scheme of interiors. As a result of the development of a program of investigation by the Joint ASHVE-*Illuminating Engineering Society* Committee on Lighting and Air Conditioning[1] in collaboration with physiologists and psychologists of the John B. Pierce Laboratory of Hygiene and others, the Committee on Research of the Society authorized a preliminary or exploratory study of the subject.

*Director, ASHVE Research Laboratory.
**Research Engr., ASHVE Research Laboratory.
***Junior Research Engr., ASHVE Research Laboratory.
[1]Committee Personnel: H. M. Sharp, *Chairman;* E. E. Ashley, A. A. Brainerd, A. D. Cameron, F. H. Faust, W. F. Friend, W. E. Stark and Walter Sturrock.

Description of Test Set-Up

Seven tests were conducted in an insulated and air conditioned room having dimensions of 17 x 8 x 10 ft high. Several exploratory tests were necessary to gain experience and practice in developing the procedure and the technique of collecting the data. As shown in the accompanying sketch (Fig. 1), a canvas screen, 6 x 6 ft, was placed at one end of the room and illuminated by the light from a 1000 w (watt) projector at the other end of the room, 15 ft distant, having a red or blue filter placed in a water bath directly in front of the projector and in the path of the light. By this means an illuminated area, approximately 5¼ ft in diameter, was obtained in the center of the screen. As shown in the figure, the light from the projector fell perpendicularly upon the screen at the center.

Two fully clothed male subjects, 20 years of age, were seated 3½ ft from the center of the screen toward either side. These subjects faced the center of the screen during the entire test. Three readily interchangeable screens were mounted on a stand. Two of the screens were painted blue and red respectively with water soluble colors, and the third screen was of white natural finish linen. Instrument measurements indicated light values falling on and reflected from the screen as given in Table 1.

When plans for the study were first considered, it was assumed that equal intensities of illumination measured in foot-candles would be possible for white, red, and blue. In attempting to get the illumination it was discovered, however, that the red and blue could only be

Table 1—Light Values Falling on and Reflected from Screen

Color of Light from Screen	Intensity of Incident Light in Plane of Screen[a]	Intensity of Light Reflected from Screen	
	Foot-Candles	Foot-Lamberts	Candles/Sq In.
White	12.0	9.0	0.020
Red	1.2	1.0	0.0020
Blue	0.6	0.47	0.00103

[a]Intensity of the incident light in foot-candles was measured by a photoelectric light meter.

had through eliminating other wave lengths of the spectrum from white light. It is very difficult, if not impossible, to provide sufficiently intense illumination from the white light in order to give approximately 15 foot-candles in the red and blue. Further, in making the observation of intensity of illumination with the photoelectric light meter, it is apparent that the indicated intensities with the different colors are not necessarily comparable, for it is well-known that the sensitivity of the instrument to light of different wave lengths varies. The values of intensity of illumination in foot-candles given in Table 1 are those indicated by the instrument. The intensity of the reflected light was measured by a Luckiesh-Taylor brightness meter.

The temperature and humidity in the room were controlled and observed at frequent intervals.

Skin temperatures were measured by means of thermocouples of No. 36 gauge wire, which were either attached so that they were imbedded in the skin by an amount equal to about one-half their diameters or mounted on movable cork buttons, which permitted them to be moved easily from point to point on the skin of either subject in a manner similar to that used in previous studies at this laboratory.

Test Procedure

Each day the room was brought to a condition of 71½ deg ET, 50 per cent relative humidity, and held at that condition for at least one hour before the subjects were permitted to enter. The mean radiant temperatures of the surroundings and the air velocity were observed to see that they remained constant. This air movement was maintained between 25 and 30 fpm. After the subjects entered the room their pulse rates and oral temperatures were taken every 10 min. At least once every 5 min an observer outside of the test room measured the skin temperature of the right fore-finger by means of the bare fixed couple and that of the left fore-finger by means of the movable cork couple. At the same time the temperature of the frontal bones of the forehead was recorded by each of these methods. In addition, every 5 min each subject was required to give an index of his feeling of warmth. Almost without exception, all comfort indices showed that the subjects were ideally comfortable while in this test, because the rooms were closely controlled at 71½ deg ET.

The original procedure suggested for these tests recommended that the subjects be exposed to the different light conditions for a period of 15 min each. Experience in the first test indicated that 15 min may not have been a long enough period for the subjects to respond to the colors. Consequently the last few tests followed the schedule described hereinafter.

For the first 1¼ hours of exposure the subjects were seated in the room looking at the white screen with normal illumination giving 12 foot-candles. After this first period was over the white light was turned off, the red screen was placed in the red light from the projector, and the subjects were required to face this red lighted screen for about 40 min. Following this they again spent 40 min facing the white screen and another 40 min facing the blue screen illuminated by the blue filter light. In order to make a further check on any effect of the colors, the subjects then were given another 40-min exposure to the white screen while they lunched. This was followed by 45 min of red illumination, 45 min of blue illumination, and finally 45 min of red illumination. By changing the color directly from red to blue and from blue to red in the latter part of the test, it was hoped to emphasize the contrast in lighting in order that any physiological changes might become more important.

Discussion of the Results

The chart, Fig. 2, shows the experimental findings for test No. 7 run on July 15. This was the last test conducted and indicates the most accurate data collected.

The horizontal scale gives the time and the color of the light experienced by the two subjects. The vertical scale is divided into five parts, giving oral and skin temperatures of subjects, *A* and *B* respectively; their pulse rates; the dry-bulb and effective temperatures, and the relative humidity of the environment. It will be seen that the dry-bulb and effective temperatures varied during the period of the test by about plus or minus ½ deg after 11

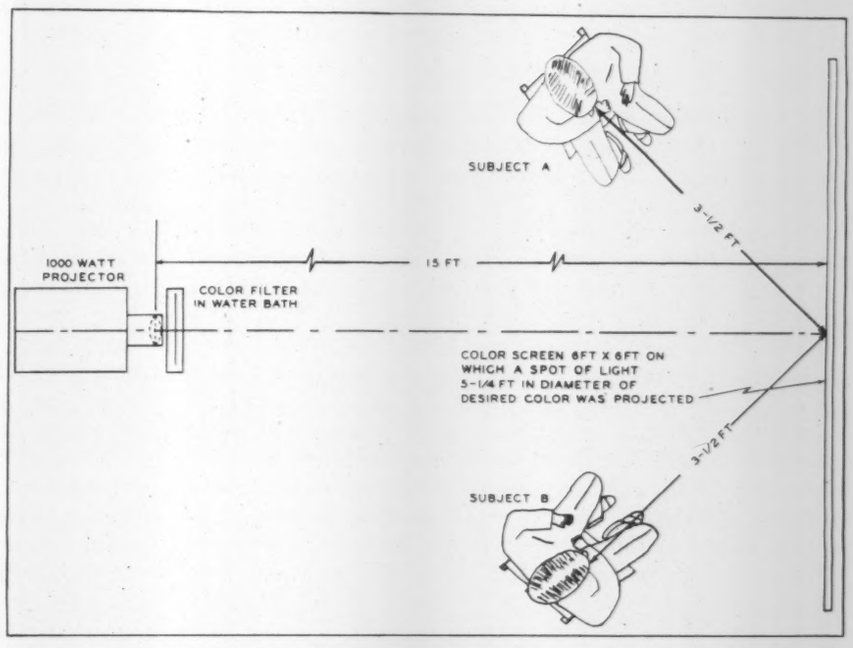

SUBJECT A
3-1/2 FT
1000 WATT PROJECTOR
15 FT
COLOR FILTER IN WATER BATH
COLOR SCREEN 6FT X 6FT ON WHICH A SPOT OF LIGHT 5-1/4 FT IN DIAMETER OF DESIRED COLOR WAS PROJECTED
3-1/2 FT
SUBJECT B

Fig. 1—Arrangement of illuminated screen, direction of projection of light and location of subjects in test room

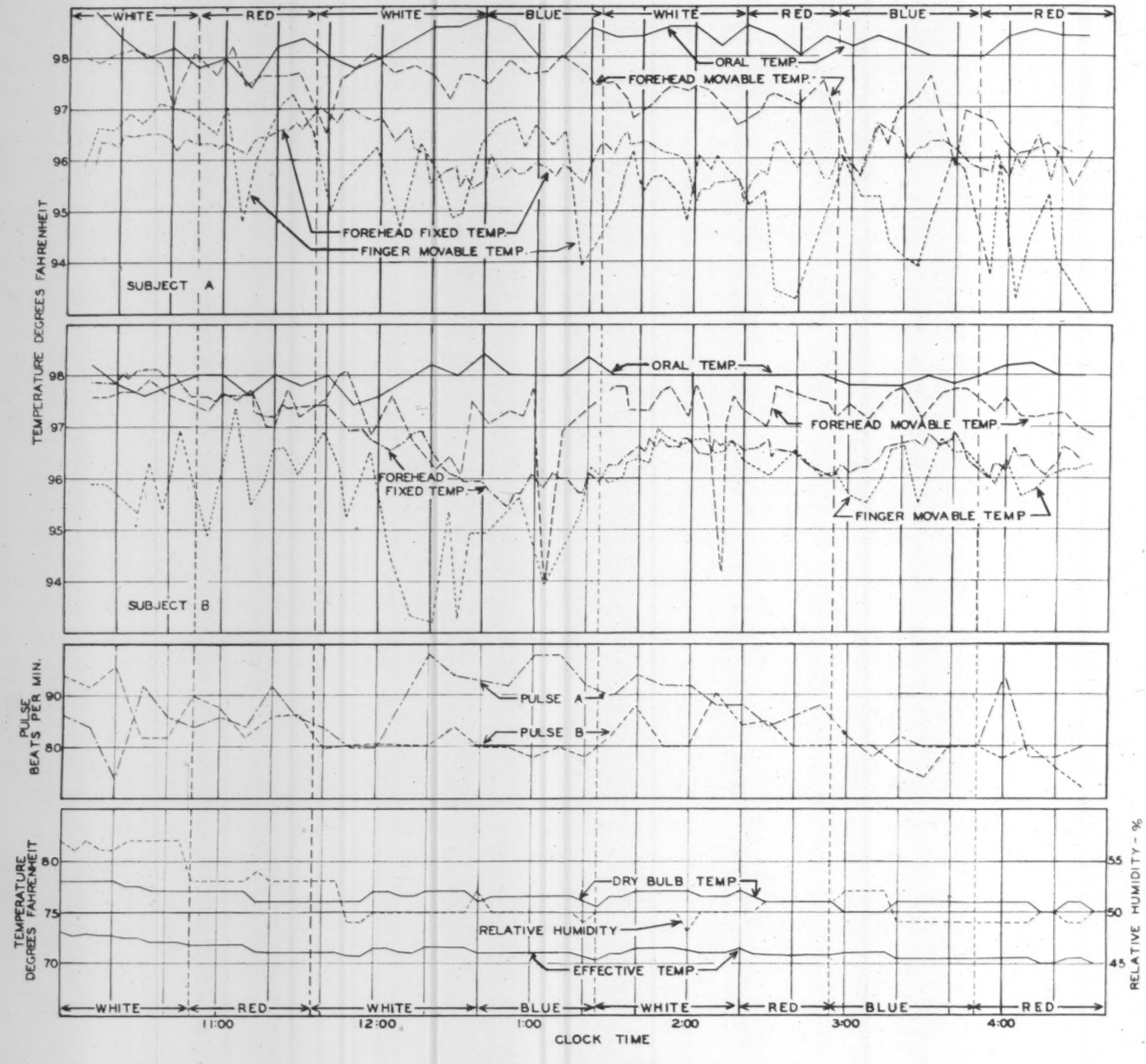


Fig. 2—Log of test No. 7

o'clock. While this precision in the control was probably satisfactory for the test, it was hoped that it could be maintained a little more closely. These tests followed immediately after the installation of silica-gel dehumidification equipment in connection with the air conditioning system, and the operation of this new equipment and the control of the conditions in the test room had not yet reached the degree of perfection which has since been possible. However, the variation in oral and skin temperatures, and in the pulse rates shows no particular correlation with these slight variations in the atmospheric condition, or with the color experienced. Hence, it may reasonably be assumed that within the limits of measurement no correlation of skin temperature and feeling of warmth was experienced due to these causes.

The oral temperature of *B* was 98 deg, plus or minus approximately ½ deg, while that of *A* was slightly higher with about the same variation. The chart of the three skin temperatures recorded shows considerable variation, including both small erratic variations from one reading to another and superimposed thereon are some general trends in either direction at different times during the test. However, none of these variations shows any correlation with the color experienced, and within the limits of measurement possible in this study it may be assumed that there was none.

The observers were asked to indicate their feelings of warmth in accordance with the scale long in use at the laboratory, whereby *ideal comfort* was indicated by 4; *slightly cool* or *slightly warm* by 3 and 5, respectively; and *cool* and *warm* by 2 and 6, respectively. However, as indicated previously, practically all observations of both subjects throughout the test were 4, or ideally comfortable. Hence, there was no object to be gained in plotting these observations. This result was to be expected since the condition of 71½ deg ET, or 76.9 dry-bulb and 50 per cent relative humidity, was designed to give ideal comfort. It has since been felt that it might have been better to run additional tests in the outer boundaries of the comfort zone, where the subjects might

experience varying feelings between comfortable and slightly warm, or comfortable and slightly cool. It has been shown in previous studies that the average person has a tolerance of from 1½ to 2 deg above and below the optimum temperature at which he is comfortable. Hence, it is conceivable that a variation in the effect of the different colors amounting to the equivalent of a change of a degree or 1½ deg might be entirely masked in this comfort tolerance.

Conclusions

In conclusion it may be said that no correlation between feeling of warmth and color of the environment was found within the comfort tolerance of the subjects, the precision of measurement, or the control of the conditions.

While it is doubtful if there is sufficient interest to warrant continued study, it is indicated that further studies (including perfection in the ability to measure skin temperature and in the control of the atmospheric environment) together with observations on the borderline where a small variation in the reaction of the individual might change his observation from comfortable to slightly warm on the one hand, and from comfortable to slightly cool on the other, or vice-versa, might make it possible to find changes in response of the subjects equivalent to what they might experience due to a temperature variation in the environment of from 1 to 1½ deg.

If such a further program is to be extended it should be organized to obtain varied data of special interest to the air conditioning engineer; the illuminating engineer; the color or paint expert; and the psychologist. Plans including the routine of carrying out the work, together with the handling of the data which should be subjected to statistical analysis, should be well prepared in advance. The number of tests necessary must be sufficient to allow for statistical handling of the results in order to bring out any small differences.

It may be observed that two types of reactions might be experienced. First, a subject exposed to a colored environment may experience an unusual sensation of warmth or coolness without any particular change in his heat production, the illumination, or the temperature requirements of the environment. If this were true such a person experiencing a feeling of warmth due to a particular color might not necessarily feel ideally comfortable at a lower temperature. On the other hand, it may be possible that such a person's psychological responses might affect his physiological responses to such an extent that he could be ideally comfortable in an atmosphere of lower temperature because of the color effect. This could also work in the other direction in that the physiological response causes the psychological reaction; both theories have been advanced by psychologists. Hence, further tests should be designed to distinguish between these two possible experiences.

Acknowledgment

The advice of L. P. Herrington of the John B. Pierce Laboratory of Hygiene in assisting in developing the program of investigation is acknowledged with appreciation by the Joint ASHVE and *Illuminating Engineering Society* Committee on Lighting and Air Conditioning, and also the cooperation of H. R. Jones of the West Penn Power Co. in performing the necessary light measurements.

New York Chapter Hears W. L. Fleisher

October 21, 1940. The New York Chapter opened its Fall Season with a meeting at the Building Trades Club, and O. O. Oaks, retiring president, introduced the incoming President, C. S. Pabst.

The officers elected to serve for the coming season are as follows:

President—C. S. Pabst
Vice-President—Joseph Wheeler, Jr.
Treasurer—W. M. Heebner
Secretary—T. W. Reynolds
Board of Governors—O. O. Oaks, H. L. Baker, Jr., R. A. Wasson, H. H. Bond and C. S. Kohler.

W. L. Fleisher, 1st vice-president of the Society, was then introduced, and gave an interesting and instructive talk on the practical application of research to air conditioning and its significance in defense preparations. Mr. Fleisher, who was chairman of the Committee on Research for the Society in 1939, spoke of the $600,000 spent by the Society on fundamental research of comfort and health while the air conditioning industry expanded from a value of $5,000,000 to its present value of over $100,000,000.

Mr. Fleisher's address detailed the results of these investigations which involved materials and apparatus required for physiological studies, sensible and latent heat of the human body, air quantities required, odor and noise effects, the effect of sunlight on cooling and heating, power and fuel savings in summer and winter by the use of insulation and double glazing. He also gave data on the orientation of buildings showing how the cost of residential heating was reduced about one third, thereby making possible the use of oil and gas and the simplification of one's whole mode of living. He mentioned some of the factors which create dangerous health conditions, and noted the increasing interest of medical and health authorities in air conditioning and comfort, origin of heat sources and their dissipation, reduction of air requirements from 30 cfm per person to 10 cfm with its reduction of the cost of theater air conditioning by more than 50 per cent. He told why people are more comfortable at higher temperatures, higher air velocities due to improvements in the design of ducts and their outlets and how the health of the worker can be protected from heat and moisture without undue expense.

The final part of the discussion was most interesting, being devoted to a discussion of possible raid shelter designs in this country. Mr. Fleisher based his recommendations of air conditioned shelters above ground on the experience of Great Britain just prior to the war and observations which he has made since.

Western New York Opens Season

October 14, 1940. The first meeting of the 1940-41 season of the Western New York Chapter was held at the University Club, with 29 members present.

The minutes of the May meeting were read and approved as read. Pres. C. A. Gifford, presiding at the meeting, announced the appointment of the following men to serve on a special committee to make arrangements for the annual Christmas party: Joseph Davis, D. J. Mahoney, Roswell Farnham, C. W. Farrar and S. W. Strouse.

It was announced that L. P. Saunders was attending the Fall Meeting of the Society in Houston, October 14-15 and that he has been nominated to serve on the Council of the Society for a three-year term.

President Gifford then introduced the guest of the evening, Ralph Mize, chief meteorologist of the Buffalo Weather Bureau, who gave a very interesting and instructive talk regarding conditions in Alaska, entitled Sewards Icebox.

Some Factors in Air Conditioning Design for a Federal Office Building

By W. A. Brown,* Washington, D. C.

Introduction

THE completely air conditioned office buildings operated by the federal government in Washington undoubtedly represent the greatest concentration of refrigeration for office building cooling in the world. A total tonnage of approximately 19,000 is in the Interior, Interstate Commerce and Labor, New Post Office, Justice, Archives, Federal Trade Commission, Interior North, Federal Home Loan Bank Board, Capitol, Senate and House Office Buildings, Federal Reserve, and Treasury. In addition, the Social Security and Railroad Retirement Board Buildings and the first wing of the War Department Building now under construction will be completely air conditioned and will add 4200 and 850 tons respectively to the total.

Economic Evaluation

There are many other older office buildings in Washington which are not air conditioned. The question is often asked if the air conditionmg of office buildings in Washington could be economically justified. Some figures are available for a group of unconditioned buildings consisting of Agriculture Administration (one center section), State, Civil Service Commission, Tariff Commission, Internal Revenue, Commerce, Arlington, and Agriculture South. Accurate records of employees in these buildings dismissed due to the heat for the summer of 1938 show that this cost was $277,445.00. The estimated annual operating cost for air conditioning for these buildings is $327,000.00. This indicates that if dismissals were eliminated by the installation of air conditioning, the resulting savings from this source alone would not pay for the operating cost. The major economic gain lies in the undoubted increase in efficiency of employees and the reduction in employee absences. These quantities have not been evaluated in government buildings but observation indicates that the increase in efficiency is, of course, most marked in the summer months.

There are about 25,864 employees in these buildings and during the 12 summer weeks they work 39 hours per week. If their earnings average $1.00 per hour, the summer payroll would be $12,108,000. If it can be assumed that the increase in efficiency in summer is worth 10 per cent, then the resulting saving is $1,210,800.

Since government buildings are conditioned all the year round, there is an increase in efficiency for 12 months of the year instead of the 3 months considered. If this figure is taken at 5 per cent, then the annual saving is $2,422,000 per year. This would take care of the operating charges and pay off the initial investment in about 5 years.

Installation and Operating Costs

As indicative of the initial costs of air conditioning to the government, the 1920 ton installation at the new Interior Building cost $1,000,000 and the 4200 ton installation at Social Security will cost about $2,000,000.

The annual operating charges for the North Interior, Interstate Commerce Commission and Labor, Justice, Post Office, Archives, Federal Trade, and New Interior Building have been combined to give the following totals for this group:

Cost of labor chargeable to air conditioning	$117,572
Cost of electric current chargeable to air conditioning	$207,375
Cost of supplies for air conditioning	$37,906
Installed tonnage	9,870

Employee Reactions

The installation of air conditioning provides comfortable and healthful conditions for government employees the year round so the great majority of the employees who work in the air conditioned buildings are in favor of air conditioning. Practically all complaints are due to poor air distribution or inadequate control, although some difficulty is experienced with a small minority whose sensations of comfort appear to be different than the average.

An idea of the general acceptance of air conditioning by government employees can be obtained from the results of a survey made by the writer, assisted by building management employees at the New Interior Building on July 20, 21, and 22, 1938.

In 1314 rooms visited the occupants were asked if conditions maintained were entirely comfortable. Only 73 people said that they were not entirely satisfied. In rooms where complaints were made, 23 were found to be exactly at design conditions, 13 were within 1 deg of design, one was 1½ deg below design and the complainant was "too warm," one was 1½ deg above design and the complainant was "too cool," two were 1 deg below design and the complainants were "too warm," two were 1 deg above design and the complainants were "cool." In this total 42 people were dissatisfied with design conditions, and of the remainder, or 31 complaints, 20 were "too cool" and 11 were "too warm." Conditions in these rooms actually were cooler or warmer than design conditions and were later corrected by supplying more or less air. The complainants were not opposed to air conditioning but were not comfortable at design conditions.

*Federal Works Agency, Public Buildings Administration.

Presented at the Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers, Washington, D. C., June, 1940.

World's Largest Office Cooling System

The federal government is proceeding with the installation of air conditioning in its newest office buildings and some details of the 4200 ton cooling system for the Social Security and Railroad Retirement Board Buildings now under construction should be of interest because it is the largest installation located in one office building in the world. There are seven 600-ton refrigerating machines located in the basement of the Social Security Building. Chilled water is circulated through coolers and dehumidifiers in a closed circuit by means of seven 1100 gpm pumps operating in parallel. Most of the dehumidifiers are placed in the penthouses of the two buildings, but some are located in basement fan rooms of both buildings.

Water for condensing purposes is cooled by means of air washers located in the penthouses of the Social Security Building. From the washers, the water flows to seven 1800 gpm pumps which recirculate it through the condensers. A total of 1,470,000 cfm or 51 tons of air per minute are required to cool this quantity of water from 100 F to 90 F.

Air is supplied to the rooms by conditioning units located under the windows. These units are fed by ducts concealed in hung ceilings below. All systems are carefully zoned in accordance with compass points. There is a total of 87 dehumidifying and cooling units supplying 1,314,795 cfm to conditioned spaces. In addition, 509,365 cfm fan capacity is provided for ventilation. The weight of sheet metal for ducts for these systems is 2,150,000 lb. There are 33,000 lineal feet of pipe required for condenser and chilled water piping and 1,000,000 sq ft of cork covering is required for the job. Connected horse power for the air conditioning system is 7502 of which 4900 hp is for the refrigeration alone.

Air Distribution and Control

In the design of systems for federal office buildings experience has indicated that air conditioning is accepted or condemned primarily through the success or failure of air distribution and control. A comfort installation which is entirely correct in all other respects will fail if the air distribution is uneven or if the control is inadequate. Even though proper temperatures and humidities are maintained local drafts will produce unequal cooling of the body and great discomfort to occupants. The ideal control system would treat each room as a separate system. Since this is much too expensive for practical consideration, as nearly individual control as possible for reasonable cost should be accomplished.

In the design of the two buildings under consideration the aim was to obtain a system of distribution and control which would eliminate so far as possible complaints due to these factors and also to obtain a system of control which would provide maximum economy in operation.

Load Considerations

Consideration of summer heat gain shows the internal sources to be due to lighting, electric machinery, and people. The lighting is indirect throughout, using approximately 4 watts per square foot. This produces a high and variable heat gain. Both buildings require a large number of electric tabulating, card punching, and card sorting machines. In the Social Security Building these machines will be located for the most part on the fourth floor, but in the Railroad Retirement Building they may be anywhere in the second to fifth wings from the second to the fourth floors, inclusive. While the maximum concentration in any one wing is known, the load factor is unknown but is sure to vary widely. Thus these machines are a source of high and variable heat gain. The concentration of people is also subject to some variation.

The external source of sensible heat gain is primarily due to the sun effect through the windows. The buildings have an unusual amount of window area, approximately 146,538 sq ft. The orientation of the buildings is such that most of the glass is subject to east or west exposure. These facts combine to produce very high peak heat gains. The amount will vary with the time of day and the day of the year and with the presence or absence of clouds. An inspection of the plan (Fig. 1) shows that due to the inside courts and wing arrangement the sun effect on the exposure varies from peak to zero due to shadows produced by other wings. The position of these shadows varies with the time of day and the day of the year.

In winter, the sources of heat gain are still the indirect lighting, electric machinery, people, and sun effect. The sun effect in winter on vertical windows is actually more intense than in summer due to the lower position of the sun, although the length of time of the effect is shorter. Another source of heat gain in winter is due to the location of steam pipes in walls, although this is minor, due to the covering of both steam and return risers.

The heat losses are due primarily to radiation through the windows. There are, of course, some radiation losses through the walls, but these are comparatively small. Whether or not rooms will require heating or cooling even on cold winter days depends upon whether or not the windows *see* the sun. Therefore, it is necessary for both heating and cooling to be available during the entire heating season.

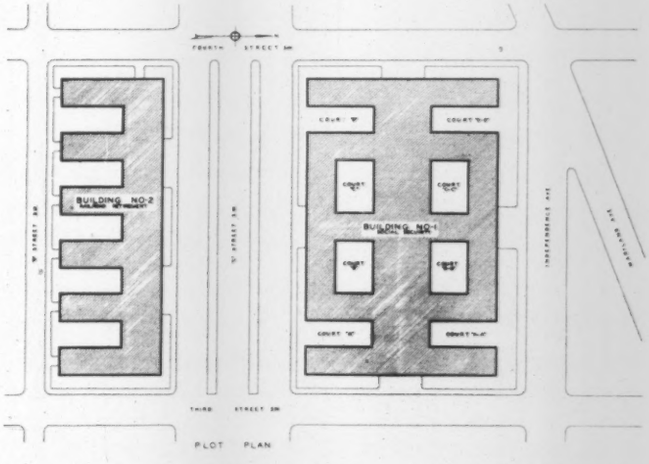


Fig. 1—Plot plan of Railroad Retirement and Social Security Buildings

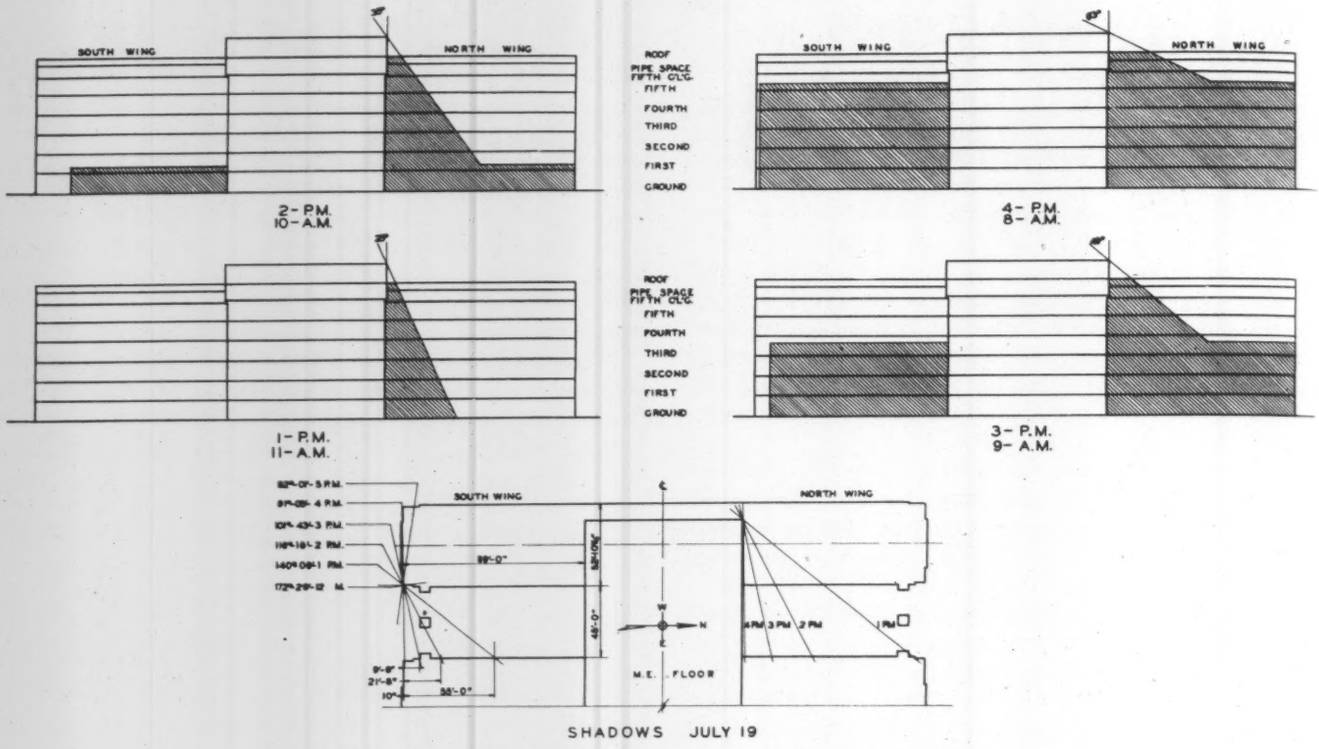


Fig. 2—Wing shading effect July 19, Social Security Building

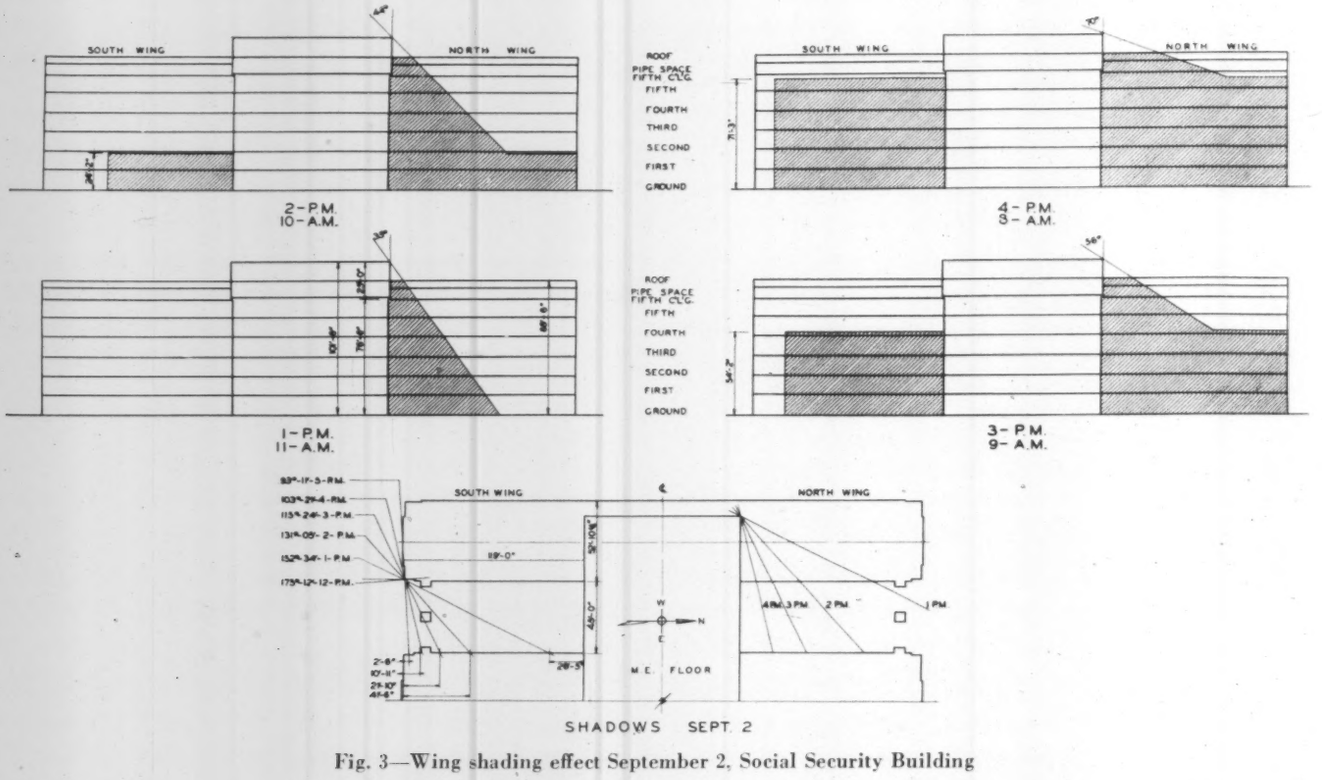


Fig. 3—Wing shading effect September 2, Social Security Building

Shading Effects

Diagrams were drawn for the different seasons showing shadow effects on the buildings. Figs. 2, 3, and 4 show the shading on the wings and Fig. 5 indicates the shading in the courts of the Social Security Building. The shading of the Railroad Retirement Building is essentially the same as the first half of Figs. 2, 3, and 4. The figures were constructed by using azimuth angle tables and calculating the altitude angle of the sun.[1] These figures show at once the lack of uniformity of sun effect on any one zone. They also indicate the necessity for some sort of individual control.

The high heat gain in summer requires the introduc-

[1]Figuring Solar Heat Gains of Buildings, by William Goodman. (*Heating, Piping and Air Conditioning*, July, 1938.)

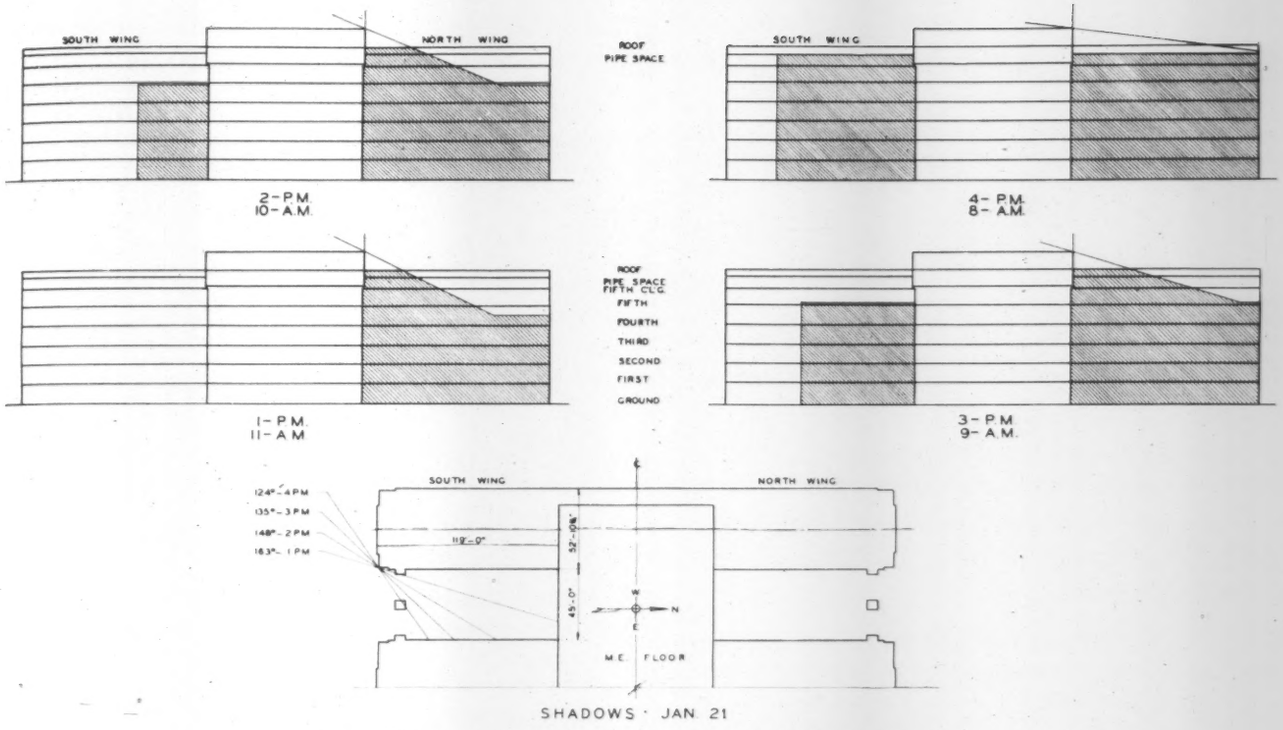


Fig. 4—Wing shading effect January 21, Social Security Building

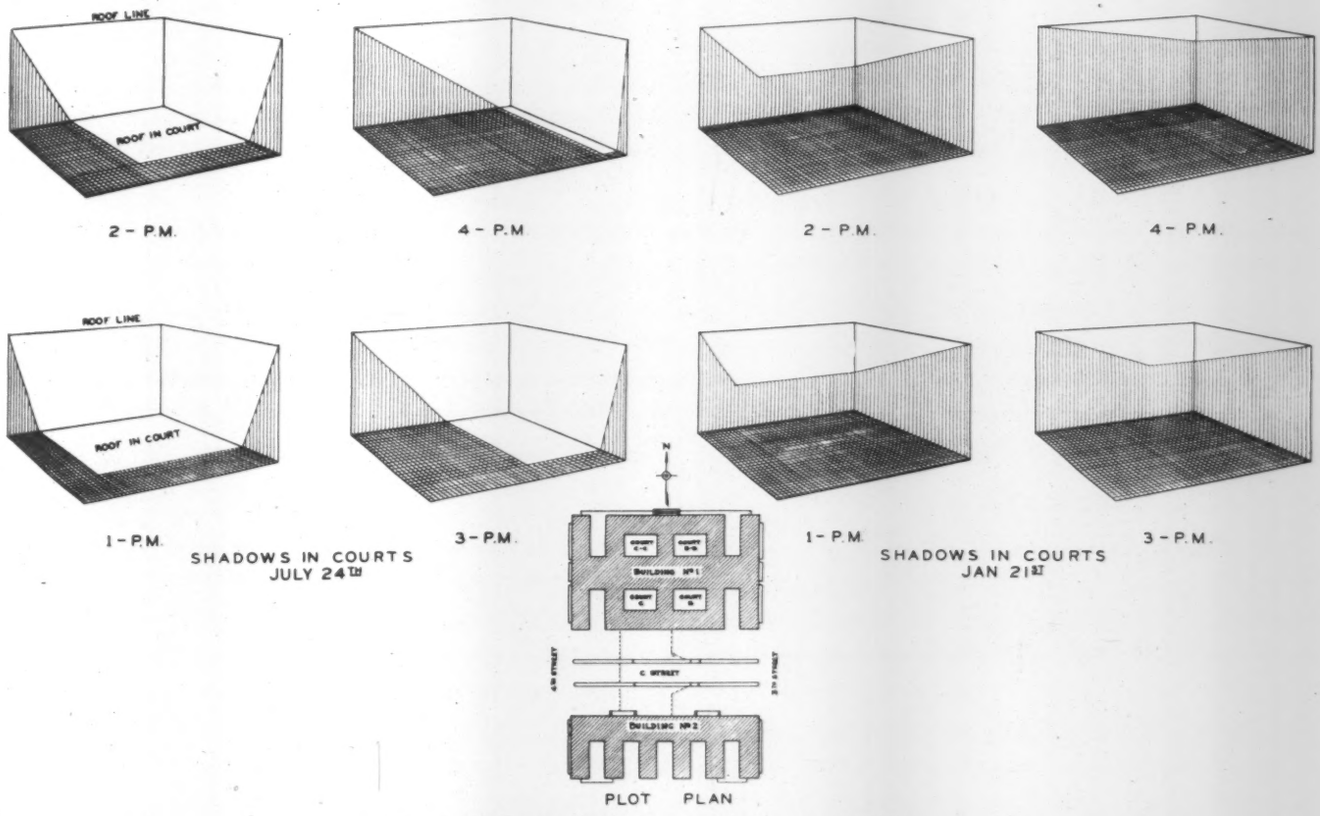


Fig. 5—Court shading effect Social Security Building

tion of large air quantities to the conditioned spaces. It is desirable to use as high a differential between entering air and room temperature as possible in order to reduce the air quantity and save on the cost of fans, motors, duct work, etc. These considerations led to the selection of window units as the means of introducing conditioned air. Experience had indicated that when properly designed, the most satisfactory air distribution results from their use, a 25 deg differential may be employed, and they are admirably suited to automatic control of not only the heating element, but also the air nozzle itself.

The individual control is obtained by local thermostats

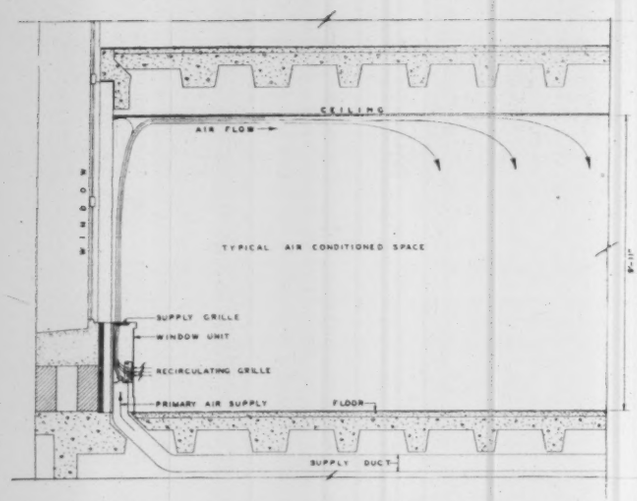


Fig. 6—Diagram of air stream leaving window unit

operating both the heating element and the air supply nozzle. In winter, with a rise in temperature the thermostat first closes down the steam valve and then opens the air nozzle by gradual action. A fall in temperature first closes the nozzle to its minimum position, after which the steam is turned on. This results in minimum use of steam. In summer steam is unavailable but the action of the thermostat is the same; with a rise in temperature the air nozzle is opened supplying more air. This control will not only maintain individual temperatures desired, but also will assist in solving the air distribution problem.

Introduction of Air

It is a common observation that drafts are more objectionable in winter than in summer. This is probably due to the fact that normal inside maximum design for summer is 74 ET, some 2½ deg ET above the optimum comfort line. On a maximum day, air motion may even be welcomed since it reduces the effective temperature. On most other summer days and in the winter, room conditions will be within the optimum ASHVE Comfort Zone and at these times excessive air motion will be found objectionable; at these times the amount of air introduced to conditioned spaces is automatically reduced by the local thermostat.

With ordinary means of introducing air, control by air supply variation is usually unsatisfactory. This is due to the fact that supply grilles are selected for definite air quantities and physical dimensions of the rooms. Changes in air quantities may result in correct temperatures but usually also result in inadequate air distribution.

This is not true of window units where the primary and recirculated room air is mixed within the unit and is then discharged vertically to the ceiling. As the nozzle slot is reduced, the proportion of induced recirculated air is increased. The discharge velocity at the sill grille is, therefore, not reduced in direct proportion to the quantity of primary air. The increased temperature of the air permits it to travel further for the same velocity. But the basic phenomenon affecting this situation is the crowding of the air against the back wall of the window unit duct to produce a thin stream of air over the entire length of the sill grille at practically uniform velocity (see Fig. 6). The smaller the slot opening the thinner this air stream so that the velocity leaving the grille is not seriously affected and the air stream reaches the ceiling. At the ceiling the air stream repeats its crowding effect, this time traveling along the ceiling in a thin stream gradually losing velocity as the air falls in a gentle downward motion.

Temperature fluctuations are of even greater concern

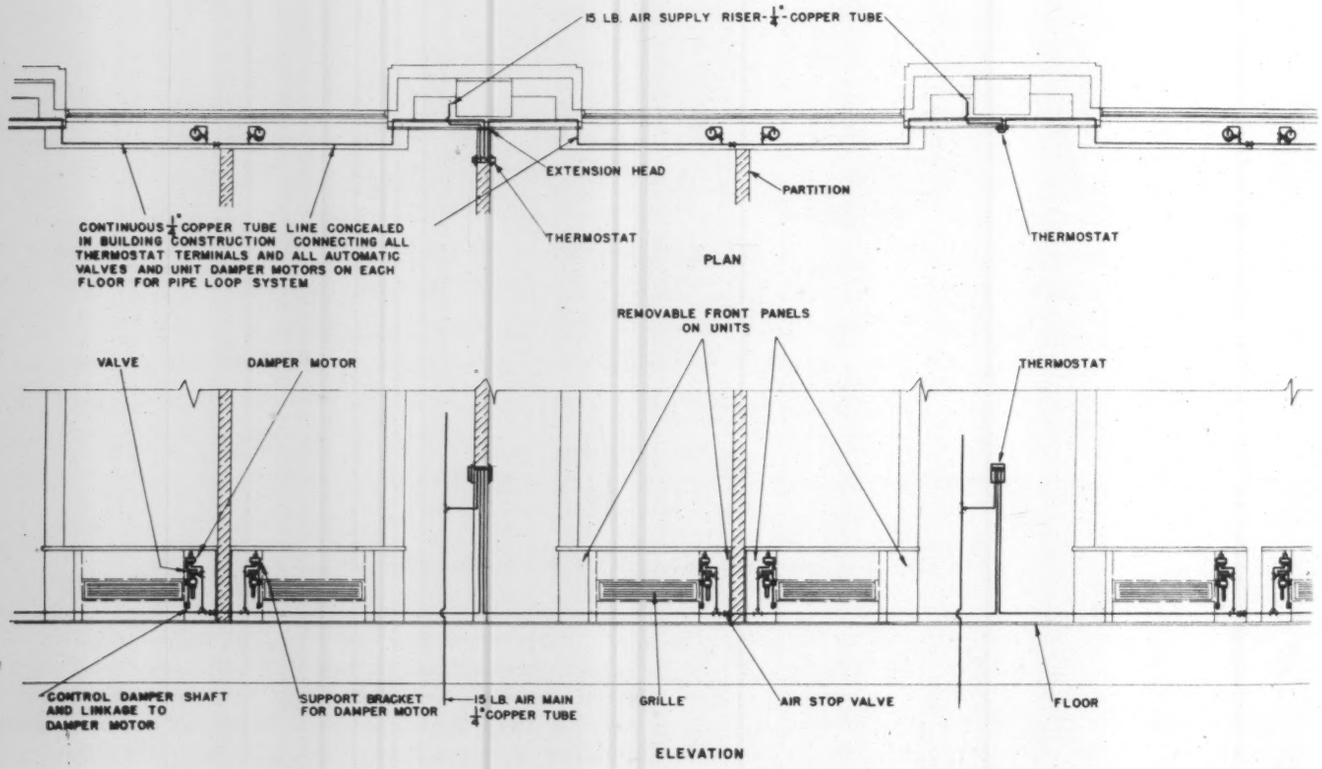

15 LB. AIR SUPPLY RISER-¼"-COPPER TUBE
EXTENSION HEAD
PARTITION
CONTINUOUS ¼" COPPER TUBE LINE CONCEALED IN BUILDING CONSTRUCTION CONNECTING ALL THERMOSTAT TERMINALS AND ALL AUTOMATIC VALVES AND UNIT DAMPER MOTORS ON EACH FLOOR FOR PIPE LOOP SYSTEM
THERMOSTAT
THERMOSTAT
PLAN
REMOVABLE FRONT PANELS ON UNITS
VALVE
DAMPER MOTOR
THERMOSTAT
CONTROL DAMPER SHAFT AND LINKAGE TO DAMPER MOTOR
SUPPORT BRACKET FOR DAMPER MOTOR
15 LB. AIR MAIN ¼"COPPER TUBE
GRILLE
AIR STOP VALVE
FLOOR
ELEVATION

Fig. 7—Arrangement pneumatic thermostat loop system installation

than temperature variations. To maintain temperatures within close limits, pneumatic control was used. Even though close temperature regulation is obtained in the immediate vicinity of the thermostat, there may result wide temperature variation and fluctuation in other parts of the room if an improper heating element is used in the window unit. The heating capacity of the element is greatly increased with the circulation of primary air. As already explained the heating capacity required for a normal day is small. With a straight tube header type heating coil (on an average day) the steam is condensed after a short travel. The result is warm air at the steam end of the unit and air at a temperature of 10 F or more below room temperature at the other end. In order to obtain uniform temperatures in the room; it is necessary to supply air of uniform temperature across the width of the unit. For this job it was required that the heating element be designed to produce this result.

Temperature Control

The central air supply system is carefully zoned in accordance with exposure. In buildings where variable sun effects are expected, such zoning is not in itself sufficient to insure proper results. If the zone thermostat controlling the temperature of air supplied to the zone is located in a room which is receiving direct sunlight, it will call for cold air with the result that rooms in shade will be too cool unless means of compensating for the different heat gains of the rooms is provided. On the other hand if the zone thermostat is located in a shaded room, then the rooms in direct sunlight will be too warm. The method adopted was to place the zone thermostat in a location which would always *see* the sun first. For shaded rooms the local thermostats reduce the air supply by throttling of the nozzle.

At the present time the partition plans for the building are not developed. Provisions were made in the window mullions for partitioning on the center of windows as well as on each pier. At such windows, two air conditioning units were provided. The future partitioning problem was met by the installation of a pneumatic loop system of such design that future thermostats could be installed to meet any possible arrangement of partitions.

Fig. 7 shows the general arrangement of the system. A pipe loop connector was located 5 ft 0 in. above the floor on each outside wall and each court wall pier throughout the building. A continuous branch line connecting each loop connector with the diaphragm valves and damper motors in the conditioner units was provided on each floor. Each loop connector was also connected to the air supply main installed as risers at each pier. With the assistance of the air stop valves shown, the entire arrangement is such that room thermostats may be installed in any location as required by future partitioning without requiring changes in the compressed air piping. Unused loop connectors are covered by neat flat plates.

In designing the control system for the central dehumidifying units, it was desired to obtain maximum economy in operation. The figures submitted on operating costs show that approximately 57 per cent is for electric current alone. Therefore, the system should be one which requires the minimum use of refrigeration.

Ordinarily, in Washington, D. C., some refrigeration is required in April and November, considerably more in May and October, and is continuously required during the summer months of June, July, August, and September.

For maximum economy the system should provide evaporative cooling without the use of refrigeration whenever possible. By this means it is hoped to confine the use of refrigeration to the summer months. When refrigeration is required, the controls should place the system on minimum or maximum outdoor air, depending upon whether or not it is more economical to use fresh or recirculated air. In this connection, considering the hours between 8 a.m. and 4 p.m. for the four months of June to September, inclusive, for an average year,[2] 27 per cent of the time the outside wet-bulb temperature will be below 67 F which is normal inside design. In other words, during the summer months, 27 per cent of the time it is more economical to operate on outdoor air than on recirculated air.

A comparatively simple system using standard control equipment was developed to accomplish the desired results. The heart of the system is shown by Fig. 8. When the fan starts, the electric pneumatic switch *E*-1 closes and normally closed minimum fresh air damper opens. Dew-point thermostat *C* controls maximum fresh air damper *C*-1 and return air damper *C*-2 through pilot valve *D*-6, chilled water valve *C*-3 through pilot valve *D*-2 and 2nd row preheater valve *C*-4 through reverse acting relay *D*-3 and pilot valve *D*-4.

For normal winter operation with the outside wet bulb temperature below 45 F, dew-point thermostat *C* is set at 45 F. On a drop in temperature, dew-point thermostat *C* wastes air to close outdoor air damper *C*-1 and to open return air damper *C*-2. After these dampers have reached their maximum positions, 2nd row preheater valve *C*-4 is opened. With a rise in temperature the operations are reversed. When the outside wet-bulb reaches 45 F, dew-point thermostat *C* will maintain its setting of 45 F by holding outdoor air damper *C*-1 wide open.

As the outside wet-bulb rises from 45 F to 55 F, dew-point thermostat *C* is reset so that its control point is raised degree for degree as the outside wet-bulb rises. Consequently outside air damper *C*-1 is open, return air damper *C*-2 is closed, chilled water valve *C*-3 and 2nd row preheater valve *C*-4 are closed and the system is operating on maximum outdoor air.

As the outside wet-bulb rises from 55 F to 67 F, dew-point thermostat *C* remains set at 55 F. Second row preheater valve *C*-4 is closed and inoperative. Chilled water valve *C*-3 is in circuit and will function if chilled water is available. On a rise in temperature, dew-point thermostat *C* supplies air to open outside air damper *C*-1, and to close return air damper *C*-2. After these dampers have attained their maximum position, chilled water valve *C*-3 is opened. System is operating with maximum outdoor air and chilled water if available.

When the outside wet-bulb is at 67 F or above, valve *C*-4 is still closed. Outside air damper *C*-1 is closed,

[2]Summer Weather Data, by J. C. Albright. (The Marley Co., First Edition, 1939, p. 85.)

return air damper *C*-2 is open and all three are in their normal positions and inoperative. Dew-point thermostat *C* is set at 55 F. On a rise in temperature it supplies air to open chilled water valve *C*-3. On a drop in temperature *C*-3 is gradually closed. The system is operating on minimum outdoor air and chilled water.

The changes in operation are affected by master wet-bulb thermostat *D* which is located in the outside air intake and pilot valves *D*-2, *D*-4, and *D*-6. As the outside wet-bulb rises from 45 F to 67 F, thermostat *D* passes air as follows: 3 lb at 45 F, 8 lb at 55 F, and 14 lb at 67 F. As the pressure increases from 3 lb to 8 lb the control point of dew-point thermostat *C* is raised from 45 F to 55 F. Below 3 lb and above 8 lb there is no change in the setting of dew-point thermostat *C*. Wet-bulb thermostat *D* is connected to the *C* ports of pilot valves *D*-2, *D*-4 and *D*-6. With 8 lb (55 F) or more on the *C* port of pilot valve *D*-2, the waste port *B* is closed and chilled water valve *C*-3 is in circuit. For

heater valve *G*-3 through *R*-*A* relay *R*-1 and pilot valve *D*-5. Either thermostat *F*, located in the zone, or *G* controls washer face damper *FG*-1 and washer by-pass damper *FG*-2.

When the outside wet-bulb is below 58 F, thermostat *F* is not in circuit. This temperature actually may not be 58 F but will be determined experimentally on the job. Fan discharge thermostat *G*, set at approximately 65 F, supplies air on a rise in temperature to close reheater valve *G*-3, then open damper *FG*-1 and close *FG*-2. On a drop in temperature the reverse action occurs.

When the outside wet-bulb is 58 F or above, thermostat *G* is not in circuit and reheater valve *G*-3 is closed. Zone thermostat *F* supplies air on a rise in temperature to open face damper *FG*-1 and close by-pass damper *FG*-2. On a drop in temperature the reverse action occurs.

These changes in operation are made by master wet-bulb thermostat *D* and pilot valves *D*-1 and *D*-5. Ther-

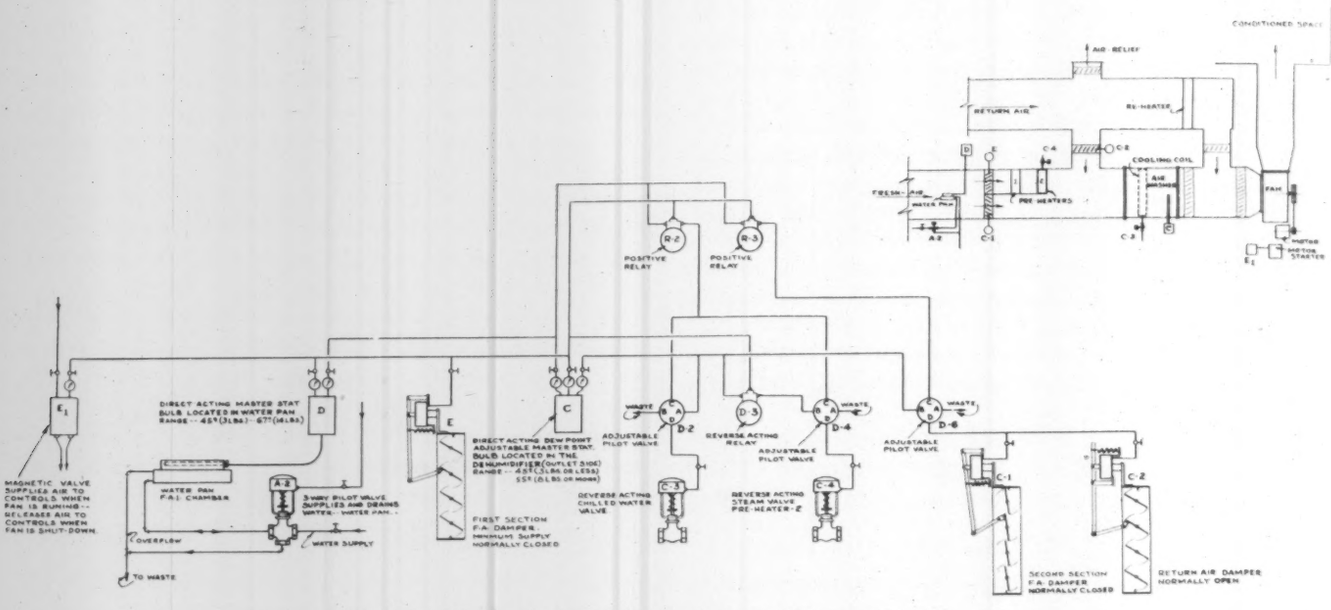


Fig. 8—Partial diagram automatic control-air conditioning

pilot valve *D*-4 the waste port *A* is opened and 2nd row preheater valve *C*-4 is closed and inoperative. At 67 F (14 lb) or above waste port *A* of pilot valve *D*-6 is open so that maximum outdoor air damper *C*-1 and return air damper *C*-2 go to their normal inoperative position which is closed and opened respectively.

The controls may be set at other values than those given above. It may be found more desirable to use 62 F than 67 F. This can easily be adjusted on the job.

Fig. 9 shows a complete typical control system. Thermostat *A* located in fresh air intake controls first row preheater valve *A*-1 so that *A*-1 is open at 35 F or below. Static regulator *B* located in return air chamber controls relief damper *B*-1 so that *B*-1 is opened with a rise in static pressure in the return air duct. When the fan stops *E*-*P* valve, *E*-1 wastes air to close *E* minimum fresh air damper, and to render all devices inoperative, allowing all valves and dampers except *A*-1 and *B*-1 to return to their normal positions.

Thermostat *G*, located at fan discharge, controls re-

mostat *D* is connected to the *C* port of pilot valves *D*-1 and *D*-5. When thermostat *D* supplies the proper air pressure, for pilot valve *D*-1 the *A* and *D* ports are connected allowing the zone thermostat *F* to control the dampers *FG*-1 and *FG*-2. For pilot valve *D*-5 the waste port *A* is opened and reheater valve *G*-3 is closed.

Static pressure regulator *H* controls fan inlet damper *H*-1. With a rise in static pressure, *H* passes air to close damper *H*-1. With a drop in static pressure, *H*-1 is gradually opened.

Thermostat *A* also controls the three-way valve *A*-2 in the line to the wet-bulb water pan for thermostat *D*. Below 35 F thermostat *A* wastes air to drain the water pan. Above 35 F water is supplied to the wet-bulb pan. Reverse acting relays *R*-1 and *D*-3 reverse the action of their respective thermostats *G* and *C*. As the thermostat pressure increases, the relay control pressure decreases. As the thermostat pressure decreases, the relay control pressure increases.

The purpose of the relief dampers is to prevent ex-

cessive pressure within the building at those times where large quantities of outdoor air are being supplied. The relief air at the dehumidifier assembly is discharged into the mechanical space under the roof. Here a series of relief dampers under the control of two static regulators in the space relieve this air to the atmosphere. These static regulators operate on the differential pressure between the mechanical space and the atmosphere.

Heat Gain in Ducts

In any air conditioning distribution system there is a rise in temperature of the air. This is due to the heat transmitted through the duct from the warmer air outside. Consequently the diffusion or temperature head which is the temperature difference between room and entering air is diminished by the amount of this temperature rise in the duct system.

For outlets close to the supply fan this temperature rise is comparatively small. In large systems for outlets at the ends of ducts the rise is considerable.

Since the temperature head in the room is diminished, it is necessary to increase the air quantity to accomplish the desired cooling. This in turn affects the duct size, the fan size, the dehumidifier and the refrigeration. The methods given in texts which cover heat gain in ducts are so long and tedious that it is not practical to employ them on large jobs.

For use on this job, a rapid practical method for the solution of this problem was derived:

Assume air flow as shown in Fig. 10. The surface S has been plotted as abscissa against the temperature of the air within the duct which changes from t_a to t_b. The temperature of the space outside is indicated by T and the temperature difference by T_D. For a change in surface, dS, the temperature of the air has changed $dt = -dT_D$.

If the specific heat of the air is C_P and W is the pounds of air flowing per unit of time, the heat dH absorbed from the area dS per unit of time is:

$$dH = C_P W dt = -C_P W dT_D$$

The heat transmitted through dS in the same time is:

$$dH = (T - t)K dS = T_D K dS$$

where

K = Btu per square foot per degree difference per hour

$$\therefore C_P W dT_D = -T_D K dS$$

$$\int_{T_{Do}}^{T_D} \frac{dT_D}{T_D} = -\frac{K}{C_P W}\int_0^S dS$$

$$\log_e \frac{T_D}{T_{Do}} = -\frac{KS}{C_P W}$$

$$\frac{T_D}{T_{Do}} = e^{-\frac{KS}{C_P W}}$$

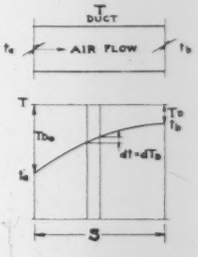


Fig. 10 — Diagram of temperature gradient through air duct

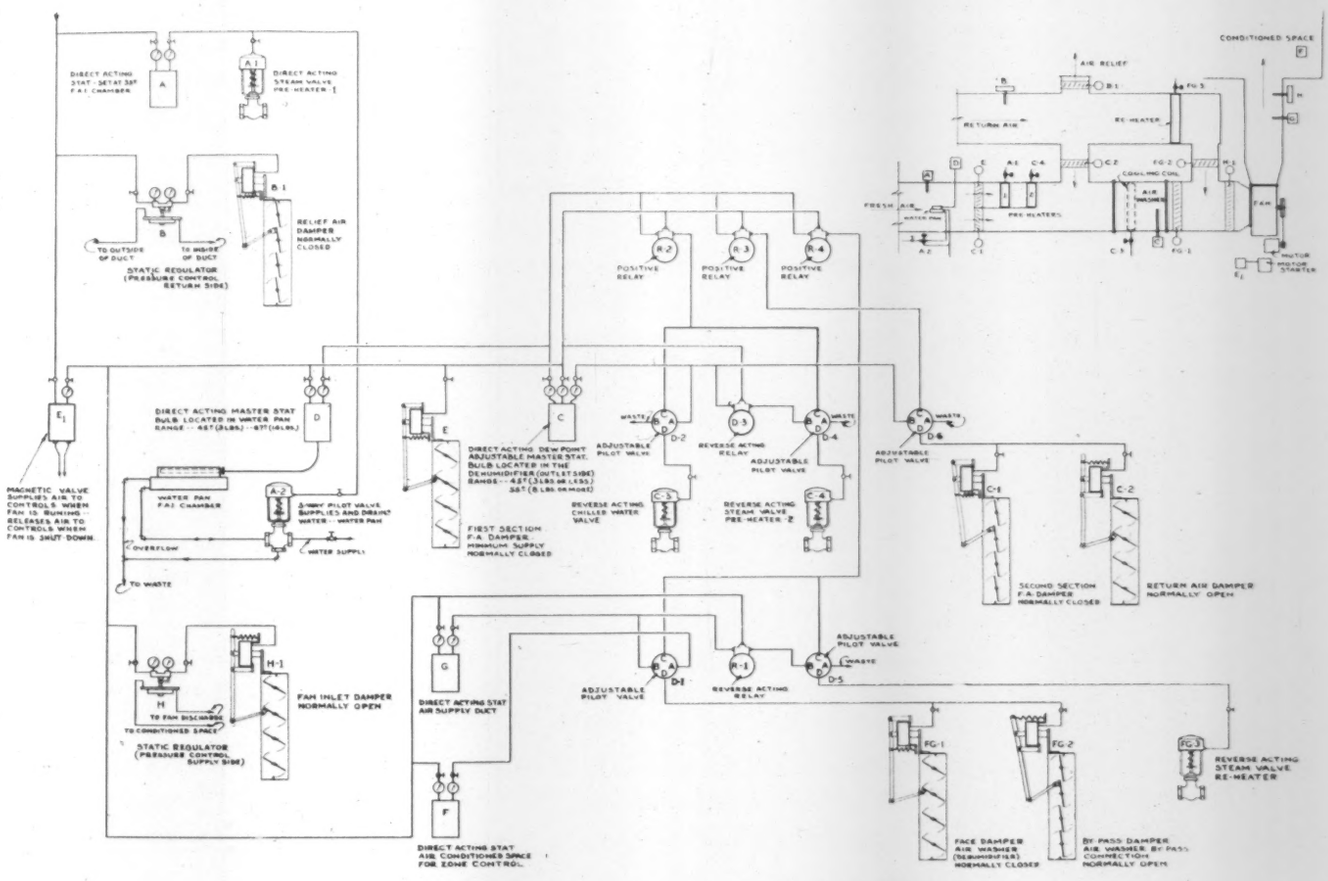

CONDITIONED SPACE
AIR RELIEF
RETURN AIR
RE-HEATER
COOLING COIL
AIR WASHER
FRESH AIR
PRE-HEATERS
FAN
MOTOR STARTER
RELIEF AIR DAMPER NORMALLY CLOSED
STATIC REGULATOR (PRESSURE CONTROL RETURN SIDE)
TO OUTSIDE OF DUCT
TO INSIDE OF DUCT
POSITIVE RELAY
DIRECT ACTING MASTER STAT BULB LOCATED IN WATER PAN
MAGNETIC VALVE SUPPLIES AIR TO CONTROLS WHEN FAN IS RUNNING RELEASES AIR TO CONTROLS WHEN FAN IS SHUT DOWN
WATER PAN F.A.I. CHAMBER
OVERFLOW
TO WASTE
WATER SUPPLY
DIRECT ACTING DEW POINT ADJUSTABLE MASTER STAT. BULB LOCATED IN THE DEHUMIDIFIER (OUTLET SIDE)
FIRST SECTION F.A. DAMPER MINIMUM SUPPLY NORMALLY CLOSED
ADJUSTABLE PILOT VALVE
REVERSE ACTING RELAY
REVERSE ACTING CHILLED WATER VALVE
REVERSE ACTING STEAM VALVE PRE-HEATER-2
SECOND SECTION F.A. DAMPER NORMALLY CLOSED
RETURN AIR DAMPER NORMALLY OPEN
FAN INLET DAMPER NORMALLY OPEN
TO FAN DISCHARGE
TO CONDITIONED SPACE
STATIC REGULATOR (PRESSURE CONTROL SUPPLY SIDE)
DIRECT ACTING STAT AIR SUPPLY DUCT
DIRECT ACTING STAT AIR CONDITIONED SPACE FOR ZONE CONTROL
REVERSE ACTING STEAM VALVE RE-HEATER
FACE DAMPER AIR WASHER (DEHUMIDIFIER) NORMALLY CLOSED
BY PASS DAMPER AIR WASHER BY PASS CONNECTION NORMALLY OPEN

Fig. 9—Complete diagram automatic control-air conditioning

$$T_D = T_{Do}\, e^{-\frac{KS}{C_P W}} \quad \ldots\ldots (1)$$

$$Let\ N = \frac{KS}{C_P W}$$

Q = cubic feet per minute
P = perimeter of duct in feet
L = length of duct in feet
at 65 F dry-bulb and 58 F dew-point

$$C_P W = \frac{\text{cfm} \times 60}{56}$$

$$Also\ S = PL$$

$$\therefore N = \frac{KPL \times 56}{Q \times 60}$$

If it is assumed that the duct has an aspect ratio of 2:1, then the area

$$A = \frac{P^2}{18}$$

$$P = \sqrt{18A} = 4.24\sqrt{A}$$

$$and\ A = \frac{Q}{V} \text{ where } V = \text{velocity}$$

$$\therefore P = 4.24\sqrt{\frac{Q}{V}}$$

$$N = \frac{56K \times 4.24\sqrt{\frac{Q}{V}}\, L}{60Q}$$

$$N = \frac{3.96KL}{Q^{\frac{1}{2}} V^{\frac{1}{2}}} \quad \ldots\ldots (2)$$

N can be solved for any value of Q if the velocity is known because K varies with the velocity. Table 1 shows values of N for bare duct, duct covered with 1-in. cork and duct covered with 2-in. cork for different values of Q assuming the velocities shown and L equal to 100 ft.

Table 1—Values of N for Bare Duct and Ducts Covered With Various Thicknesses of Cork

CFM	V	K	N		
	FT/MIN	BTU/SQ FT/ DEG/DIFF/HR.	BARE DUCT	1-IN. CORK	2-IN. CORK
20,000	1500	1.7	0.123	0.017	0.011
15,000	1500	1.7	0.142	0.02	0.013
12,000	1500	1.7	0.159	0.022	0.014
10,000	1450	1.7	0.177	0.025	0.016
8,000	1400	1.68	0.199	0.028	0.018
6,000	1300	1.65	0.234	0.033	0.021
4,000	1150	1.62	0.3	0.042	0.027
3,000	1050	1.58	0.353	0.049	0.032
2,000	950	1.54	0.444	0.062	0.04
1,500	900	1.52	0.517	0.072	0.047
1,000	800	1.47	0.652	0.091	0.059
800	750	1.44	0.735	0.103	0.066
600	700	1.41	0.861	0.120	0.077
400	650	1.37	1.062	0.149	0.095
300	600	1.34	1.25	0.175	0.113
200	550	1.29	1.535	0.215	0.138
150	500	1.28	1.85	0.259	0.166

From the preceding table Fig. 11 was made to obtain values of N for different values of cubic feet per minute without interpolation.

$$\text{Temperature rise } T_R = T_{Do} - T_D$$
$$= T_{Do} - T_D{}^o\, e^{-N}$$
$$= T_{Do}\,(1 - e^{-N}) \quad \ldots\ldots (3)$$

For values of N from o to 0.1, for all practical purposes $1 - e^{-N} = N$. For such values of N to obtain the temperature rise, it is only necessary to multiply the temperature difference between inside and outside of duct by the value of N obtained from Fig. 11.

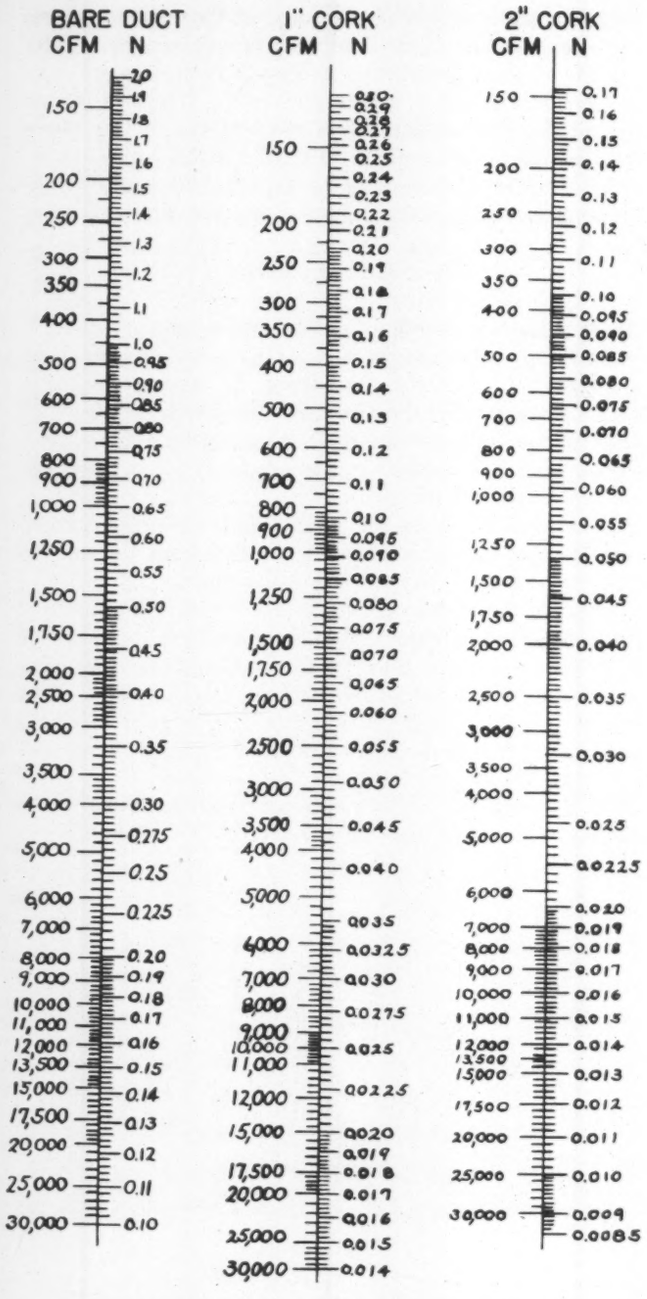


Fig. 11—Values of N for various air volumes

The larger N is, the greater the error in assuming $1 - e^{-N} = N$. For values of $N > 0.1$ Table 2 should be used. This table was constructed by using the value of $1 - e^{-N}$.

In developing Formula (2) an aspect ratio of 2:1 was employed. With this aspect ratio $P = 4.24\sqrt{A}$.

If the aspect ratio is 3:1 then the sides of the duct are $3P/8$ and $P/8$.

$$A = \frac{3P^2}{64}$$

$$P = 4.62\ A$$

Table 2—Values of N for Various Temperature Differences Between Air Inside and Outside Duct

N	TEMP. DIFF. BETWEEN AIR INSIDE AND OUTSIDE DUCT																	
	10	12	14	16	18	20	22	25	27	30	32	35	37	40	42	45	47	50
0.005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.01	.10	.12	.14	.16	.18	.20	.22	.25	.27	.30	.32	.35	.37	.40	.42	.45	.47	.50
.02	.198	.236	.277	.317	.356	.396	.436	.495	.535	.594	.634	.693	.733	.792	.832	.891	.931	.990
.03	.296	.355	.416	.474	.533	.592	.651	.740	.799	.888	.947	1.04	1.10	1.18	1.24	1.33	1.39	1.48
.04	.392	.470	.549	.627	.706	.784	.862	.980	1.06	1.18	1.25	1.37	1.45	1.57	1.65	1.76	1.84	1.96
.05	.488	.586	.683	.781	.878	.976	1.07	1.22	1.32	1.46	1.56	1.71	1.81	1.95	2.05	2.20	2.29	2.44
.06	.582	.698	.815	.931	1.05	1.16	1.28	1.46	1.57	1.75	1.86	2.04	2.15	2.33	2.44	2.62	2.74	2.91
.07	.676	.811	.946	1.08	1.22	1.35	1.49	1.69	1.83	2.03	2.16	2.37	2.50	2.70	2.84	3.04	3.18	3.38
.08	.769	.923	1.08	1.23	1.38	1.54	1.69	1.92	2.08	2.31	2.46	2.69	2.85	3.08	3.23	3.46	3.61	3.85
.09	.861	1.03	1.21	1.38	1.55	1.72	1.89	2.15	2.32	2.58	2.76	3.01	3.19	3.44	3.62	3.87	4.05	4.31
.10	.952	1.14	1.33	1.52	1.71	1.90	2.09	2.38	2.57	2.86	3.05	3.33	3.52	3.81	4.00	4.28	4.47	4.76
.11	1.04	1.25	1.46	1.67	1.88	2.08	2.29	2.61	2.81	3.13	3.33	3.65	3.86	4.17	4.38	4.69	4.90	5.21
.12	1.13	1.36	1.58	1.81	2.04	2.26	2.49	2.83	3.05	3.39	3.62	3.96	4.18	4.52	4.75	5.09	5.32	5.66
.13	1.22	1.45	1.71	1.95	2.19	2.44	2.68	3.05	3.29	3.66	3.90	4.27	4.51	4.88	5.12	5.49	5.73	6.10
.14	1.31	1.57	1.83	2.09	2.35	2.61	2.87	3.27	3.53	3.92	4.18	4.57	4.83	5.22	5.49	5.88	6.14	6.53
.15	1.39	1.67	1.95	2.23	2.51	2.79	3.06	3.48	3.76	4.18	4.46	4.88	5.15	5.57	5.85	6.27	6.55	6.97
.16	1.48	1.77	2.07	2.37	2.66	2.96	3.25	3.70	3.99	4.44	4.73	5.18	5.47	5.92	6.21	6.66	6.95	7.40
.17	1.56	1.88	2.19	2.50	2.81	3.13	3.44	3.91	4.22	4.69	5.00	5.47	5.78	6.25	6.56	7.03	7.35	7.82
.18	1.65	1.98	2.31	2.64	2.96	3.29	3.62	4.12	4.45	4.94	5.27	5.76	6.09	6.59	6.92	7.41	7.74	8.24
.19	1.73	2.08	2.42	2.77	3.11	3.46	3.81	4.33	4.67	5.19	5.54	6.06	6.40	6.92	7.27	7.79	8.13	8.65
.20	1.81	2.18	2.54	2.90	3.26	3.63	3.99	4.53	4.90	5.44	5.80	6.35	6.71	7.25	7.61	8.16	8.52	9.07
.21	1.89	2.27	2.65	3.03	3.41	3.79	4.17	4.74	5.11	5.68	6.06	6.63	7.01	7.58	7.95	8.52	8.90	9.47
.22	1.98	2.37	2.76	3.16	3.56	3.95	4.35	4.94	5.33	5.93	6.32	6.91	7.31	7.90	8.30	8.89	9.28	9.88
.23	2.06	2.47	2.88	3.29	3.70	4.11	4.52	5.14	5.55	6.17	6.58	7.19	7.60	8.22	8.63	9.25	9.66	10.28
.24	2.13	2.56	2.99	3.41	3.84	4.27	4.69	5.34	5.76	6.40	6.83	7.47	7.90	8.54	8.96	9.60	10.03	10.67
.25	2.21	2.65	3.10	3.54	3.98	4.42	4.87	5.53	5.97	6.64	7.08	7.74	8.18	8.85	9.29	9.95	10.40	11.06
.26	2.29	2.75	3.20	3.66	4.12	4.58	5.04	5.72	6.18	6.87	7.32	8.01	8.47	9.16	9.61	10.30	10.76	11.45
.27	2.37	2.84	3.31	3.78	4.26	4.73	5.20	5.91	6.39	7.10	7.57	8.28	8.75	9.46	9.93	10.64	11.12	11.83
.28	2.44	2.93	3.42	3.91	4.40	4.88	5.37	6.11	6.59	7.33	7.81	8.55	9.04	9.77	10.26	10.99	11.48	12.21
.29	2.52	3.02	3.52	4.03	4.53	5.03	5.54	6.29	6.80	7.55	8.05	8.81	9.31	10.07	10.57	11.33	11.83	12.59
.30	2.59	3.11	3.63	4.15	4.67	5.18	5.70	6.48	7.00	7.78	8.29	9.07	9.59	10.37	10.89	11.66	12.18	12.96
.31	2.67	3.20	3.73	4.27	4.80	5.33	5.87	6.67	7.20	8.00	8.53	9.33	9.86	10.66	11.20	12.00	12.53	13.33
.32	2.74	3.29	3.83	4.38	4.93	5.48	6.03	6.85	7.40	8.22	8.76	9.59	10.13	10.96	11.50	12.33	12.87	13.70
.33	2.81	3.37	3.94	4.50	5.06	5.62	6.18	7.03	7.59	8.43	9.00	9.84	10.40	11.24	11.81	12.65	13.21	14.06
.34	2.88	3.46	4.03	4.61	5.19	5.76	6.34	7.20	7.78	8.64	9.22	10.08	10.66	11.52	12.10	12.96	13.54	14.41
.35	2.95	3.54	4.13	4.72	5.32	5.91	6.50	7.38	7.97	8.86	9.45	10.34	10.93	11.81	12.40	13.29	13.88	14.77
.36	3.02	3.63	4.23	4.84	5.44	6.05	6.65	7.56	8.16	9.07	9.67	10.58	11.19	12.09	12.70	13.60	14.21	15.12
.37	3.09	3.71	4.33	4.95	5.57	6.19	6.80	7.73	8.35	9.28	9.90	10.83	11.44	12.37	12.99	13.92	14.54	15.47
.38	3.16	3.79	4.43	5.06	5.69	6.32	6.95	7.90	8.53	9.48	10.12	11.06	11.70	12.64	13.28	14.22	14.86	15.81
.39	3.23	3.87	4.52	5.17	5.81	6.46	7.10	8.07	8.72	9.69	10.33	11.30	11.95	12.92	13.56	14.53	15.18	16.15
.40	3.30	3.96	4.62	5.28	5.93	6.59	7.25	8.24	8.90	9.89	10.55	11.54	12.20	13.19	13.85	14.84	15.50	16.49
.41	3.36	4.04	4.71	5.38	6.06	6.73	7.40	8.41	9.08	10.09	10.76	11.77	12.45	13.46	14.13	15.14	15.81	16.82
.42	3.43	4.12	4.80	5.49	6.17	6.86	7.55	8.58	9.26	10.29	10.98	12.00	12.69	13.72	14.41	15.44	16.12	17.15
.43	3.50	4.19	4.89	5.59	6.29	6.99	7.69	8.74	9.44	10.49	11.18	12.23	12.93	13.98	14.68	15.73	16.43	17.48
.44	3.56	4.27	4.98	5.70	6.41	7.12	7.83	8.90	9.61	10.68	11.39	12.46	13.17	14.24	14.95	16.02	16.73	17.80
.45	3.62	4.35	5.07	5.80	6.52	7.25	7.97	9.06	9.78	10.87	11.60	12.68	13.41	14.50	15.22	16.31	17.03	18.12
.46	3.69	4.42	5.16	5.90	6.64	7.37	8.11	9.22	9.95	11.06	11.80	12.90	13.64	14.75	15.49	16.59	17.33	18.44
.47	3.75	4.50	5.25	6.00	6.75	7.50	8.25	9.38	10.13	11.26	12.00	13.13	13.88	15.00	15.75	16.88	17.63	18.75
.48	3.81	4.57	5.34	6.10	6.86	7.62	8.39	9.53	10.29	11.44	12.20	13.34	14.10	15.25	16.01	17.15	17.92	19.06
.49	3.87	4.65	5.42	6.20	6.97	7.75	8.52	9.69	10.46	11.62	12.40	13.56	14.33	15.50	16.27	17.43	18.21	19.37
.50	3.94	4.72	5.51	6.30	7.08	7.87	8.66	9.84	10.62	11.81	12.59	13.77	14.56	15.74	16.53	17.71	18.49	19.68
.51	4.00	4.80	5.60	6.40	7.20	8.00	8.80	10.00	10.80	12.00	12.80	14.00	14.80	16.00	16.80	18.00	18.80	20.00
.52	4.05	4.86	5.67	6.48	7.29	8.10	8.91	10.13	10.94	12.15	12.96	14.18	14.99	16.20	17.01	18.23	19.04	20.25
.53	4.11	4.93	5.75	6.58	7.40	8.22	9.04	10.28	11.10	12.33	13.15	14.39	15.21	16.44	17.26	18.50	19.32	20.55
.54	4.17	5.00	5.83	6.67	7.51	8.34	9.17	10.43	11.26	12.51	13.34	14.60	15.43	16.68	17.51	18.77	19.60	20.85
.55	4.23	5.08	5.92	6.77	7.61	8.46	9.31	10.58	11.42	12.69	13.54	14.81	15.65	16.92	17.77	19.04	19.88	21.15
.56	4.29	5.15	6.01	6.86	7.72	8.58	9.44	10.73	11.58	12.87	13.73	15.02	15.87	17.16	18.02	19.31	20.16	21.45
.57	4.36	5.21	6.08	6.94	7.81	8.68	9.55	10.85	11.72	13.02	13.89	15.19	16.06	17.36	18.23	19.53	20.40	21.70
.58	4.40	5.28	6.16	7.04	7.92	8.80	9.68	11.00	11.88	13.20	14.08	15.40	16.28	17.60	18.48	19.80	20.68	22.00
.59	4.46	5.35	6.24	7.14	8.03	8.92	9.81	11.15	12.04	13.38	14.27	15.61	16.50	17.84	18.73	20.07	20.96	22.30
.60	4.51	5.41	6.31	7.22	8.12	9.02	9.92	11.28	12.18	13.53	14.43	15.79	16.69	18.04	18.94	20.30	21.20	22.55
.61	4.57	5.48	6.40	7.31	8.23	9.14	10.05	11.43	12.34	13.71	14.62	16.00	16.91	18.28	19.19	20.57	21.48	22.85
.62	4.62	5.54	6.47	7.39	8.32	9.24	10.16	11.55	12.47	13.86	14.78	16.17	17.09	18.48	19.40	20.79	21.71	23.10
.63	4.67	5.60	6.54	7.47	8.41	9.34	10.27	11.68	12.61	14.01	14.94	16.35	17.28	18.68	19.61	21.02	21.95	23.35
.64	4.73	5.68	6.62	7.57	8.51	9.46	10.41	11.83	12.77	14.19	15.14	16.56	17.50	18.92	19.87	21.29	22.23	23.65
.65	4.78	5.74	6.69	7.65	8.60	9.56	10.52	11.95	12.91	14.34	15.30	16.73	17.69	19.12	20.08	21.51	22.47	23.90
.66	4.83	5.80	6.76	7.73	8.69	9.66	10.63	12.08	13.04	14.49	15.46	16.91	17.87	19.32	20.29	21.74	22.70	24.15
.67	4.88	5.86	6.83	7.81	8.78	9.76	10.74	12.20	13.18	14.64	15.62	17.08	18.06	19.52	20.50	21.96	22.94	24.40
.68	4.93	5.92	6.90	7.89	8.87	9.86	10.85	12.33	13.31	14.79	15.78	17.26	18.24	19.72	20.71	22.19	23.17	24.65
.69	4.98	5.98	6.97	7.97	8.96	9.96	10.96	12.45	13.47	14.94	15.94	17.43	18.43	19.92	20.92	22.41	23.41	24.90
.70	5.03	6.04	7.04	8.05	9.05	10.06	11.07	12.58	13.58	15.09	16.10	17.61	18.61	20.12	21.13	22.64	23.66	25.15
.71	5.08	6.10	7.11	8.13	9.14	10.16	11.18	12.70	13.72	15.24	16.26	17.78	18.80	20.32	21.34	22.86	23.88	25.40
.72	5.13	6.16	7.18	8.21	9.23	10.26	11.29	12.83	13.85	15.39	16.42	17.96	18.98	20.52	21.55	23.09	24.11	25.65
.73	5.18	6.22	7.25	8.29	9.32	10.36	11.40	12.95	13.97	15.54	16.58	18.13	19.17	20.72	21.76	23.31	24.35	25.90
.74	5.23	6.28	7.32	8.37	9.41	10.46	11.51	13.08	14.12	15.69	16.74	18.31	19.35	20.92	21.97	23.54	24.58	26.15
.75	5.28	6.34	7.39	8.45	9.50	10.56	11.62	13.20	14.26	15.84	16.90	18.48	19.54	21.12	22.18	23.76	24.82	26.40
.76	5.32	6.38	7.45	8.51	9.58	10.64	11.70	13.30	14.36	15.96	17.02	18.62	19.68	21.28	22.34	23.94	25.00	26.60
.77	5.37	6.44	7.52	8.59	9.67	10.74	11.81	13.43	14.50	16.11	17.18	18.80	19.87	21.48	22.55	24.17	25.24	26.85
.78	5.42	6.50	7.59	8.67	9.76	10.84	11.92	13.55	14.63	16.26	17.34	18.97	20.05	21.68	22.76	24.39	25.47	27.10
.79	5.46	6.55	7.64	8.74	9.83	10.92	12.01	13.65	14.74	16.38	17.47	19.11	20.20	21.84	22.93	24.57	25.66	27.30
.80	5.51	6.61	7.71	8.82	9.92	11.02	12.12	13.78	14.88	16.53	17.63	19.29	20.39	22.04	23.14	24.80	25.90	27.55
.81	5.55	6.66	7.77	8.88	9.99	11.10	12.21	13.88	14.99	16.65	17.76	19.43	20.54	22.20	23.31	24.98	26.09	27.75
.82	5.60	6.72	7.84	8.96	10.08	11.20	12.32	14.00	15.12	16.80	17.92	19.60	20.72	22.40	23.52	25.20	26.32	28.00
.83	5.64	6.77	7.90	9.02	10.15	11.28	12.41	14.10	15.23	16.92	18.05	19.74	20.87	22.56	23.69	25.38	26.51	28.20
.84	5.68	6.82	7.95	9.09	10.22	11.36	12.50	14.20	15.34	17.04	18.18	19.88	21.02	22.72	23.86	25.56	26.70	28.40
.85	5.73	6.88	8.02	9.17	10.31	11.46	12.61	14.33	15.47	17.19	18.34	20.06	21.20	22.92	24.07	25.79	26.93	28.65
.86	5.77	6.92	8.08	9.23	10.39	11.54	12.69	14.43	15.58	17.31	18.46	20.20	21.35	23.08	24.23	25.97	27.12	28.85
.87	5.81	6.97	8.13	9.30	10.46	11.62	12.78	14.53	15.69	17.43	18.59	20.34	21.50	23.24	24.40	26.15	27.31	29.05
.88	5.85	7.02	8.19	9.36	10.53	11.70	12.87	14.63	15.80	17.55	18.72	20.48	21.65	23.40	24.57	26.33	27.50	29.25
.89	5.89	7.07	8.25	9.42	10.60	11.78	12.96	14.73	15.90	17.67	18.85	20.62	21.79	23.56	24.74	26.51	27.68	29.45
.90	5.93	7.12	8.30	9.49	10.67	11.86	13.05	14.83	16.01	17.79	18.98	20.76	21.94	23.72	24.91	26.69	27.87	29.65
.91	5.97	7.16	8.36	9.55	10.75	11.94	13.13	14.93	16.12	17.91	19.10	20.90	22.09	23.88	25.07	26.87	28.06	29.85
.92	6.01	7.21	8.41	9.62	10.82	12.02	13.22	15.03	16.23	18.03	19.23	21.04	22.24	24.04	25.24	27.05	28.25	30.05
.93	6.05	7.26	8.47	9.68	10.89	12.10	13.31	15.13	16.34	18.15	19.36	21.18	22.39	24.20	25.41	27.23	28.44	30.25
.94	6.09	7.31	8.53	9.74	10.96	12.18	13.40	15.23	16.44	18.27	19.49	21.32	22.53	24.36	25.58	27.41	28.62	30.45
.95	6.13	7.36	8.58	9.81	11.03	12.26	13.49	15.33	16.55	18.39	19.62	21.46	22.68	24.52	25.75	27.59	28.81	30.65
.96	6.17	7.40	8.64	9.87	11.11	12.34	13.57	15.43	16.66	18.51	19.74	21.60	22.83	24.68	25.91	27.77	29.00	30.85
.97	6.21	7.45	8.69	9.94	11.18	12.42	13.66	15.53	16.77	18.63	19.87	21.74	22.98	24.84	26.08	27.95	29.19	31.05
.98	6.25	7.50	8.75	10.00	11.25	12.50	13.75	15.63	16.88	18.75	20.00	21.88	23.13	25.00	26.25	28.13	29.38	31.25
.99	6.28	7.54	8.79	10.05	11.30	12.56	13.82	15.70	16.96	18.84	20.10	21.98	23.24	25.12	26.38	28.26	29.52	31.40
1.00	6.32	7.58	8.85	10.11	11.38	12.64	13.90	15.80	17.06	18.96	20.22	22.12	23.38	25.28	26.54	28.44	29.70	31.60
1.10	6.67	8.00	9.34	10.67	12.01	13.34	14.67	16.68	18.01	20.01	21.34	23.35	24.68	26.68	28.01	30.02	31.35	33.35
1.20	6.99	8.39	9.79	11.18	12.58	13.98	15.38	17.48	18.87	20.97	22.37	24.47	25.86	27.96	29.36	31.46	32.85	34.95
1.30	7.29	8.72	10.18	11.63	13.09	14.54	15.99	18.18	19.63	21.81	23.26	25.45	26.90	29.08	30.53	32.72	34.17	36.35
1.40	7.53	9.04	10.54	12.05	13.55	15.06	16.57	18.83	20.33	22.59	24.10	26.36	27.86	30.12	31.63	33.89	35.39	37.75
1.50	7.77	9.32	10.88	12.43	13.99	15.54	17.09	19.43	20.98	23.31	24.86	27.20	28.75	31.08	32.63	34.97	36.52	38.85
1.60	7.98	9.58	11.17	12.77	14.36	15.96	17.56	19.95	21.55	23.94	25.54	27.93	29.53	31.92	33.52	35.91	37.51	39.90
1.70	8.17	9.80	11.44	13.07	14.71	16.34	17.97	20.43	22.06	24.51	26.14	28.60	30.23	32.68	34.31	36.77	38.40	40.85
1.80	8.35	10.02	11.69	13.36	15.03	16.70	18.37	20.88	22.55	25.05	26.72	29.23	30.90	33.40	35.07	37.58	39.25	41.75
1.90	8.50	10.20	11.90	13.60	15.30	17.00	18.70	21.25	22.95	25.50	27.20	29.75	31.45	34.00	35.70	38.25	39.95	42.50
2.00	8.65	10.38	12.11	13.84	15.57	17.30	19.03	21.63	23.36	25.95	27.68	30.28	32.01	34.60	36.33	38.93	40.66	43.25
N	10	12	14	16	18	20	22	25	27	30	32	35	37	40	42	45	47	50
	TEMP. DIFF. BETWEEN AIR INSIDE AND OUTSIDE DUCT																	

Table 3—Correction Factors for Commonly Used Insulators

Insulation	
Material	Factor
½ in. Air Acoustic Sheets	0.24
1 in. Air Acoustic Sheets	0.14
½ in. Asbestocel Sheets (2 ply)	0.30
1 in. Asbestocel Sheets (4 ply)	0.19
1 in. Cork	0.14
1½ in. Cork	0.10
2 in. Cork	0.09

Table 4—Correction Factors for Shape of Ducts

Shape of Ducts	
Aspect Ratio	Factor
2:1	1.00
3:1	1.00
4:1	1.18
5:1	1.265
6:1	1.35
7:1	1.43
8:1	1.50
9:1	1.58
10:1	1.65

Table 5—Correction Factors for Duct Length

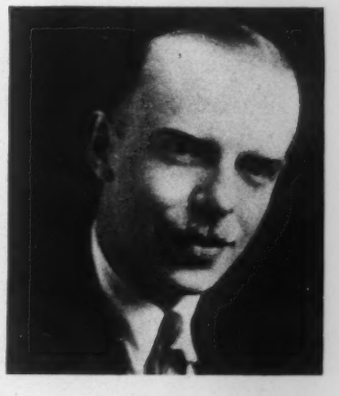
Length in Feet	Factor
10	0.1
20	0.2
30	0.3
40	0.4
50	0.5
60	0.6

Therefore, the correction factor for an aspect ratio of 3:1 is $\frac{4.62}{4.24} = 1.09$. Similarly correction factors for other aspect ratios are found as shown in Table 4.

Table 3 lists correction factors to be used as a multiplier of N to obtain the corrected N for commonly used insulators. These factors are actual loss in per cent of bare duct loss.

Table 5 lists correction factors to be used as a multiplier of N for lengths. Inasmuch as 100 ft was used in obtaining values of N from Formula (2) the correction is quite simple.

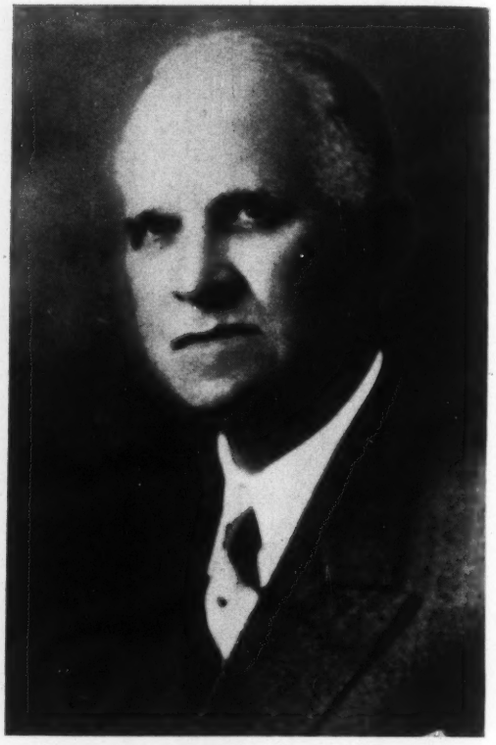
Tom Brown To Cleveland



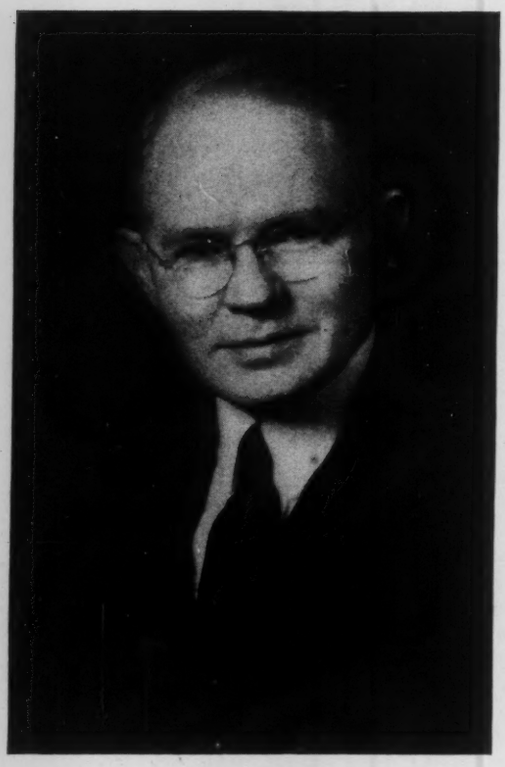
Announcement has been made by Lester T. Avery, president of Avery Engineering Co., 1906 Euclid Ave., Cleveland, O., that Tom Brown has assumed his new duties in the company's Koolshade department, where he will be responsible for the wholesale and retail department in Ohio and Western New York. Mr. Brown was formerly vice-president of Autovent Fan & Blower Co., Chicago, and previously operated as manufacturer's representative in Detroit. During the past year he served as president of the Illinois Chapter and previously he had been secretary of Michigan Chapter of the Society.

Nominees for ASHVE Officers in 1941

W. L. Fleisher
New York, N. Y.
President



E. O. Eastwood
Seattle, Wash.
First Vice-President



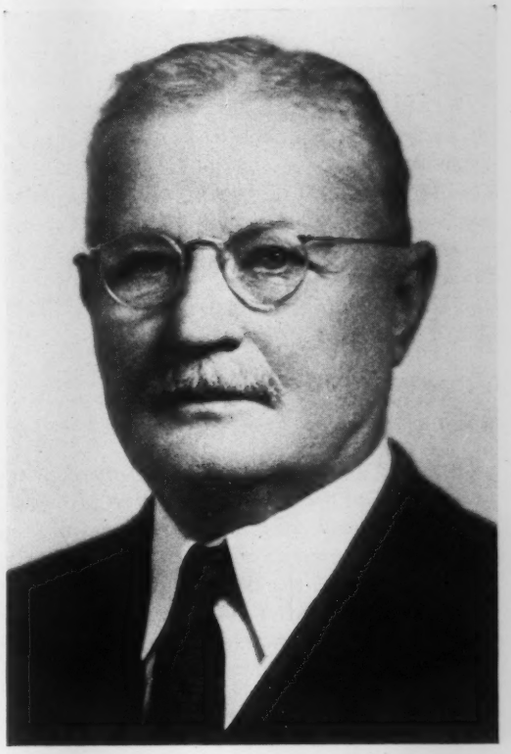
J. H. Walker
Detroit, Mich.
Second Vice-President

M. F. Blankin
Philadelphia, Pa.
Treasurer

Fall Meeting at Houston

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Rice Hotel, Houston, Tex.
October 14-15, 1940



F. E. Giesecke, College Station, Tex.
President—1940

IN AN autumn setting and with delightful weather members of the Society enjoyed the hospitality of Houston for the 1940 Fall Meeting held at the Rice Hotel, October 14 and 15. Members from 11 states were present and representatives from both the Atlantic and Pacific Coasts were among those registered.

For those who came early the Committee on Arrangements planned some pre-meeting entertainment, and 20 members and ladies saw the Rice vs. L. S. U. football game in Rice Stadium, Saturday night, October 12. On Sunday morning George Maves led the golfers to Brae Burn Country Club, and in the afternoon, W. R. Etie conducted a sightseeing group of 14 to San Jacinto Monument, the Houston Ship Channel, through Galveston, and several oil fields.

The Reception Committee was on hand early Monday morning to greet the arriving members, ladies and guests, and 152 registered for the technical sessions and nearly 200 attended the banquet.

FIRST SESSION—

Monday, October 14

The first session was called to order by Pres. F. E. Giesecke promptly at 10:00 a. m., Monday, October 14, at the Rice Hotel, and a brief address of welcome was delivered by Robert J. Cummins, president of the Texas Section of *ASCE*. An appropriate response to this hearty welcome was made by President Giesecke, after which he introduced J. van O. Weaver, vice-chairman of the Committee on Arrangements. He expressed the regrets of Chairman C. A. McKinney, who was called away unexpectedly and could not return in time for the meeting.

Prof. A. P. Kratz, Urbana, Ill., was introduced and presented the first technical paper entitled Development of Instruments for the Study of Air Distribution in Rooms by A. P. Kratz, A. E. Hershey and R. B. Engdahl (complete paper published in September 1940 ASHVE JOURNAL SECTION, *Heating, Piping and Air Conditioning.*)

He described a wind tunnel which was constructed for the calibration of anemometers over a velocity range of 20 to 2000 fpm and told of the construction and use of a heated thermocoupled anemometer.

In the discussion some questions were asked and comments were offered by Arthur Nutting, Louisville, Ky., L. P. Saunders, Lockport, N. Y., D. S. Cooper, Houston, E. P. Heckel, Chicago, R. W. Barnes, San Antonio, F. C. Houghten, Pittsburgh, and M. Noble, Syracuse, N. Y.

A native son of Texas, W. G. Darley, Cleveland, Ohio, gave his paper Cooler Footcandles for Air Conditioning (complete paper published in August 1940 ASHVE JOURNAL SECTION, *Heating, Piping and Air Conditioning*). In the development of better lighting he explained that ventilating and illuminating engineers were confronted with three specific problems involving total heat liberated in a space, radiant heat from light source and a complex physio-psychological reaction of the occupants to the color and brightness of the light. He then spoke of the new horizons being opened up by new light sources.

Comments and questions were invited and those who

participated in the discussion were R. J. Salinger, Houston, N. D. Adams, Rochester, Minn., Prof. H. E. Degler, Austin, and R. B. Bartlett, Bloomington, Ill.

The third paper at the morning session was given by the author, F. R. Bichowsky, entitled Chemical Dehumidification Agents (complete paper published in October 1940 ASHVE JOURNAL SECTION, *Heating, Piping and Air Conditioning*). He discussed the selection of the proper type of drying agent for chemical dehumidification and various types of equipment. In a brief discussion D. S. Cooper, Houston, and S. C. Bell, Bloomington, Ill., commented on the paper.

SECOND SESSION—

Tuesday, October 15

Technical discussions were resumed when President Giesecke called the second session to order at 10:00 a. m., October 15. Prof. H. E. Degler, Austin, was introduced and gave his paper Weather Conditions in Texas *vs.* Human Comfort (complete paper published on page 675.) He described the variety of weather experienced in the State of Texas and discussed design conditions and comfort requirements. Some comments were offered by W. L. Fleisher, New York, and N. D. Adams, Rochester, Minn.

First Vice-President Fleisher presided and F. C. Houghten, director of the ASHVE Research Laboratory, Pittsburgh, gave an interesting talk on Our Present and Future Research Program. He gave a brief resumé of the problems being investigated and presented some details of the work on ducts and radiant heating.

Among those who asked questions were President Giesecke, College Station, Professor Kratz, Urbana, R. B. Bartlett, Bloomington, Ill. and M. W. Brown, Dallas.

A. J. Rummel, president of the South Texas Chapter, San Antonio, was the next speaker and his paper was Direct Evaporative Cooling for Homes in the Southwest (complete paper published in October 1940 ASHVE JOURNAL SECTION, *Heating, Piping and Air Conditioning*). In this presentation he gave a detailed analysis of Texas climate and discussed the application of direct evaporative cooling in residences in the Southwest.

Those who took part in the discussion were Leo Hungerford, Los Angeles, E. K. Campbell, Kansas City, R. K. Werner, Fort Worth, and Professor Kratz.

At the close of the discussion E. K. Campbell, of Kansas City, offered the following resolutions which were unanimously adopted:

WHEREAS, THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS assembled in Houston, Texas, for the Southwestern Regional Fall Meeting 1940, desires to express appreciation for the many courtesies received.

BE IT RESOLVED THAT the Committee on Arrangements and all of the Sub-Committees of South Texas Chapter be complimented on the arrangements which have been so well planned and so smoothly carried out for the enjoyment of everybody present.

THAT, we especially commend the efforts of the ladies of the South Texas Chapter who have made the stay of the visiting ladies so pleasant and enjoyable.

THAT, we appreciate highly the program arranged by the Banquet Committee. We liked the humor of the toastmaster, John F. Scott. We thoroughly enjoyed the able address of the President of A. & M. College, Dr. T. O. Walton.

A sightseeing party at San Jacinto Monument

THAT, we thank the Rice Hotel for their service, the unfailing courtesies of all of the employees and the cooperation of the management in making our meeting a success.

THAT, we appreciate the contributions of the authors of papers for their presence and the very valuable data presented, also the extremely interesting discussions.

THAT, we have greatly enjoyed the sightseeing trips to see things that are peculiar to the Gulf Coast—the Ship Channel, the San Jacinto Battleground Memorial, Galveston and its sea wall, and some of the many air conditioning installations and industrial plants in Houston.

THAT, we are greatly pleased with the cooperation rendered by the staff and the services furnished by the Houston Chamber of Commerce to assure the success of our meeting.

THAT, we enjoyed the inspiring luncheon talk of W. M. Ryan on the History of Texas.

THAT, we appreciate the unusual interest of the newspapers and their reporters, who have been attentive and generous in publicizing our meeting and interviewing our officers and many of our members.

THAT, the notable work of the Publicity Committee be recognized for the volume and extent of the coverage, which indicates careful and intelligent planning, and

FINALLY THAT, it is a great pleasure to thank the South Texas Chapter for fulfilling its promise that the finest kind of weather would prevail at this time of year; we have enjoyed the beautiful weather to the utmost, we have had a wonderful time, and we are glad we came to Houston.

As no further business was brought before the meeting it was voted to adjourn.

Entertainment

Monday at noon a get-together luncheon was served to 90 members, guests and ladies. A. J. Rummel, President of South Texas Chapter, presided and introduced the speaker, W. M. Ryan, a prominent attorney of Houston, whose subject was The History of Texas. The address was most interesting and inspiring and President Giesecke expressed the thanks of the members to Mr. Ryan at the conclusion of his talk.

During the afternoon many of the members and ladies enjoyed a sightseeing trip through Houston's fine residential section, the campus of Rice Institute, San Jacinto Battleground and nearby oil fields and refineries.

At 4:30 p. m. an informal Friendship Hour was held

in the American and French Rooms and refreshments were served.

The banquet was held at 7 o'clock in the grand ballroom and nearly 200 were present to enjoy an excellent menu featuring Texas beef steak. At the conclusion of dinner John F. Scott presided as toastmaster and President Giesecke introduced distinguished guests, the officers of the Society, Council members and the Chapter officers and committees.

Dr. T. O. Walton, president of A. & M. College of Texas, gave an entertaining address on the Industrial Development of Texas.

After dinner the floor was cleared for dancing, which was enjoyed until 12:30, to the music of John Sullivan and his orchestra.

The program was planned by A. M. Chase, Jr., and the members of his Banquet Committee. The interesting table decorations of cotton bolls, rice heads, and pumpkins were arranged by Mrs. Chase.

On Tuesday the ladies assembled at 10:45 a. m. for a bridge-luncheon and style show in the Sam Houston Room of the Rice Hotel. Those who received remembrances of the occasion were Mrs. G. D. Maves, Houston; Mrs. F. E. Giesecke, College Station; Mrs. R. J. Salinger, Houston; and Mrs. G. A. Linskie, Dallas.

At the invitation of the Houston Junior Chamber of Commerce many of the members attended a special luncheon and heard a fine address by Stanley Foran on Americanism—Let's Resell it to the World.

During the afternoon inspection trips were made to several of Houston's completely air conditioned office buildings, the Champion Fiber and Paper Co. plant and the power station of the Houston Lighting and Power Co.

The Committees in charge of arrangements were:

C. A. McKinney, *General Chairman*
J. van O. Weaver, *Vice-Chairman*

Publicity
J. A. Walsh
H. J. Martyn

Registration
D. S. Cooper
J. A. Bishop

Tours
I. A. Nattan
W. L. Barnes
S. H. Green
R. J. Salinger

Entertainment
A. B. Banowsky
R. M. Spencer
C. R. Gardner
I. E. Rowe

Transportation
W. R. Etie
F. A. Rodgers
Warren Earl

Finance
R. F. Taylor
R. J. Salinger
R. K. Werner

Ladies
A. F. Barnes
L. C. McClanahan
R. M. Spencer
J. D. Morrow

Sports
G. D. Maves
A. I. Mitchell
R. W. Kurtz
R. G. Lyford

Banquet
A. M. Chase, Jr.
R. E. Tucker
B. J. Beaird
G. R. Rhine
M. L. Brown

A regular meeting of the Council was held on Monday afternoon and those in attendance were: Pres. F. E. Giesecke, W. L. Fleisher, Merrill F. Blankin, N. D. Adams, E. K. Campbell, J. F. Collins, Jr., A. P. Kratz, A. J. Offner, and by invitation W. A. Russell and L. P. Saunders.

Ventilation on Shipboard Discussed at Philadelphia

October 10, 1940. The regular meeting of the Philadelphia Chapter was held at the Engineers Club. The meeting, which was called to order by Pres. C. B. Eastman, was preceded by a short talk by a representative of the American Red Cross, who requested financial support for the Red Cross at the annual roll call.

After several letters were read advising members that positions were available for engineers of various qualifications, the president called attention to the Fall Meeting of the Society in Houston, Tex. Merrill F. Blankin was then called upon to tell of the plans for the Annual Meeting to be held in Philadelphia in January, 1942. Mr. Blankin, who is General Chairman for this meeting, requested cooperation and suggestions from the membership, and announced that plans for this meeting were under way.

A motion was made by A. J. Nesbitt to have the nominating committee consist of L. P. Hynes, W. A. Bornemann, H. H. Erickson, M. G. Kershaw and S. E. Plewes. It was moved and seconded and duly carried that the nominations be closed, and the secretary was then instructed to cast the ballot for the nominees as given.

H. H. Mather, chairman of the meetings committee, announced that Prof. F. E. Giesecke, College Station, Tex., will be the guest speaker at the November meeting.

W. T. Breckinridge, air conditioning engineer, New York Shipbuilding Co., was introduced and addressed the meeting on the subject of ventilation on shipboard. He stressed the fundamental design factor to be met in warship heating and ventilating systems. Considerable discussion followed and numerous questions were put to Mr. Breckinridge. Following this interesting discussion the meeting was adjourned at 9:20 p. m.

Survey by Research Advisory Service

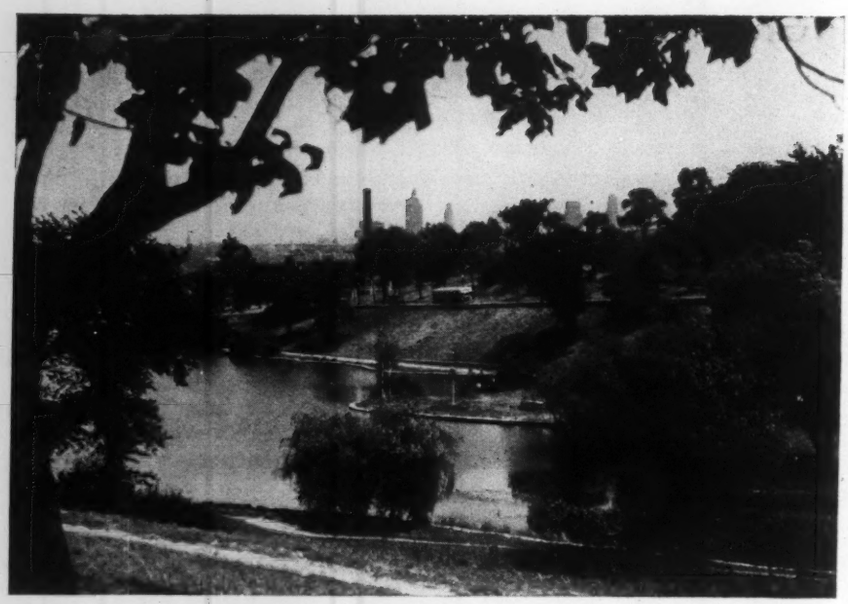
The result of a survey completed by the Research Advisory Service, New York, has just been published and indicates the thoughts of a group of business leaders concerning the research required to supply the needs of many industries. An analysis of over 1,000 replies to the question "What new product, process or material might industrial research develop that would be valuable to your industry?", indicates that 38 fields were covered.

Under the title "Industry's Challenge to Research" a check list of industrial requirements that need to be filled today is given in this 43-page digest. There are 18 major items listed under heating and air conditioning; 11 under building construction; and 9 under fuels.

Advisory Committee on Engineering Defense Training Appointed

Appointment of an Advisory Committee to the U. S. Office of Education on Engineering Training for National Defense was announced recently by J. W. Studebaker, U. S. Commissioner of Education.

Those appointed to serve on this committee represent leading engineering schools and colleges and are as follows: A. A. Potter, dean of engineering, Purdue University, chairman; F. L. Bishop, secretary, Society for Promotion of Engineering Education, Pittsburgh; R. E. Doherty, president, Carnegie Institute of Technology; Gibb Gilchrist, dean of engineering, A. and M. College of Texas; H. P. Hammond, dean of engineering, Pennsylvania State College; W. O. Hotchkiss, president, Rensselaer Polytechnic Institute; R. S. McBride, consulting engineer, Washington, D. C.; Thorndike Saville, dean of engineering, New York University; C. C. Williams, president, Lehigh University; B. M. Woods, chairman of department of mechanical engineering, University of California, and a member of the Committee on Research of the ASHVE; and A. W. Horton, Jr., U. S. Office of Education.



Kansas City Prepares January Program

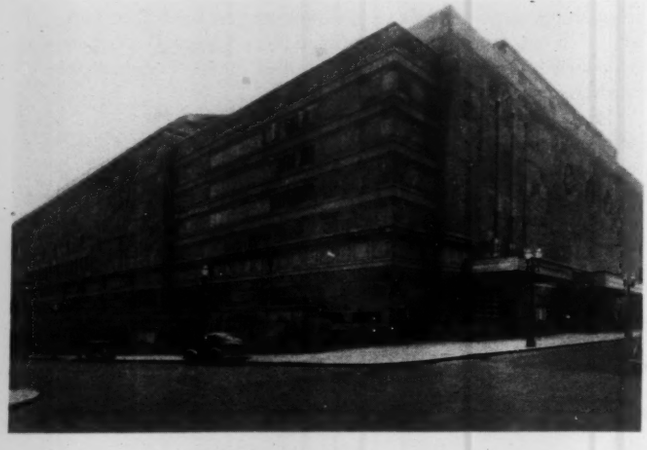
THE Committee on Arrangements of the Kansas City Chapter held a meeting on Friday, October 18, and outlined the program for the Society's 47th Annual Meeting to be held at the Hotel Muehlebach, January 27-29, 1941.

General Chairman John M. Arthur, Jr., received reports from the various sub-committees, and announced that registration would commence at 8:30 a.m., January 27. During the morning committee meetings would be held, as well as a conference of chapter delegates. It is planned to hold a get-together luncheon at noon on Monday and an informal get-together party during the evening.

There will be four technical sessions, and the annual banquet and dance will be held on Tuesday evening, January 28.

Special events for ladies are being planned by the committee headed by Mrs. W. A. Russell.

W. L. Cassell, president of the Kansas City Chapter, sends all members an invitation to come to Kansas City for the Society's 47th Annual Meeting.



Municipal Auditorium

Air Conditioning in National Defense Topic at Pittsburgh Meeting

October 14, 1940. Pres. F. C. McIntosh called the October meeting of the Pittsburgh Chapter to order in the Marine room of the Roosevelt Hotel with 27 members and guests present. Minutes of the April meeting and May Advisory Board meeting were read by the secretary, and approved as read.

L. S. Maehling presented a report on financial matters, and H. B. Steggall, chairman of the program committee, announced that Pres. F. E. Giesecke would speak at the November meeting and had chosen radiant heating and cooling as his subject.

President McIntosh then announced those on the nominating committee as follows: P. A. Edwards, *chairman;* G. G. Waters and R. J. J. Tennant.

E. S. Scanlon, in reporting on the proposed chapter research project, stated that there was some doubt about the legal status of such gifts to the University of Pittsburgh and the proposed plan had been abandoned.

The chapter was fortunate in having three speakers at this meeting, all of whom discussed some phase of air conditioning in national defense. W. H. Reed, III, Pittsburgh, spoke generally on the problem of industrial air conditioning, and L. W. Cordrey, York, Pa., described, insofar as military regulations would permit, some unusual air conditioning plants such as are required for the many new windowless factory buildings and the extremely low air pressure and temperatures now used for airplane engine testing. Lt. Rush Bowman, Ordnance Dept., U. S. Army, spoke on the effect of change in atmospheric environment upon the accuracy of precision instruments and gages. He also described the Ordnance Department Gage Laboratory at Carnegie Institute of Technology. Following an interesting discussion the meeting adjourned at 10:00 p.m.

Connecticut Chapter Appoints Committees

The Connecticut Chapter held a meeting October 1, and Prof. L. E. Seeley, New Haven, who has been acting as temporary president, announced the appointment of the following committees:

Membership—C. W. Stewart, chairman; H. E. Adams, H. P. Peterson, G. S. Williams and P. K. Turner.

Nominating—W. K. Simpson, chairman; L. A. Teasdale, T. S. Hart, C. J. Lyons and J. R. Smak.

Committee for Arrangements of Charter Meeting Night—C.-E. A. Winslow, chairman; Stanley Hart, I. C. Jennings and F. E. Earle.

By-Laws and Rules for the Connecticut Chapter were submitted and approved at this meeting, and E. J. Rodee, New Haven, who has been acting as temporary secretary, announced that Prof. F. E. Giesecke, president of the Society, will be the guest of honor at the charter meeting on November 8, at which time the nominating committee will present a slate of officers to be elected and the chapter will receive its charter.

Wisconsin Holds First Meeting of Season

September 16, 1940. The first regular monthly meeting of the Wisconsin Chapter was held at the City Club with a total of 45 members and guests in attendance.

The meeting was opened with an address by Pres. A. S. Krenz, who expressed a wish that the chapter do some constructive work to obtain greater public recognition for heating, ventilating and air conditioning engineers and assist in providing unbiased professional services. He asked for the cooperation and assistance of the chapter members in increasing the growth and strength of the Society.

C. H. Randolph, chairman of the program committee for the Chapter, gave a resumé of what to expect in future meetings and asked the members to express their opinions as to the type of speakers they would desire. It is planned to have F. C. Houghten, director of the Society's Research Laboratory, Pittsburgh, as the speaker at the December meeting.

A motion was made by I. J. Rossiter to have a speaker talk on the effect of the sun on glass block and water sprays on the roof, rather than on effective temperatures, as it was felt that such a talk would be of more general interest than a discussion on effective temperatures.

Mr. Randolph also brought up the subject of having joint meetings with the *American Society of Refrigerating Engineers,* and it was concluded that this would be a desirable step to take.

It was suggested that monthly meeting notices be sent to the local secretaries of the *Heating and Piping Contractors Association* and the *Sheet Metal Contractors Association.*

J. S. Jung then introduced the guest of the evening, A. G. Dixon, Racine, Wis., who spoke on the design and commercial application of unit heaters. Mr. Dixon gave an interesting talk, which was greatly appreciated by the members, as evidenced by the enthusiasm that prevailed. Following the discussion Mr. Jung thanked Mr. Dixon on behalf of the Society for his excellent address, after which the meeting was adjourned.

Atlanta Chapter Opens Fall Season

September 10, 1940. The first fall meeting of the Atlanta Chapter was held at the Biltmore Hotel, with Pres. T. T. Tucker presiding. President Tucker and L. F. Kent, secretary of the Chapter, reported on the Semi-Annual Meeting of the Society in Washington, D. C.

H. King McCain, chairman of the research committee, gave a report on the progress of the attic ventilation project. He advised that the Society had appropriated $400.00 for this work, with the understanding that the Atlanta Chapter would give $200.00 and $600.00 to be contributed by Georgia Tech. A motion was carried authorizing the chapter to contribute $100.00 in cash and materials, and in addition to the $65.00 fan already contributed, $35.00 is to be paid from the cash on hand.

C. B. Cole, a member of the research committee, was authorized to raise $100.00 from other sources to make the $200.00 to be supplied by the chapter.

Professor Hinton of Georgia Tech gave some interesting information on the progress made in testing the fan to be used on this project and outlined the general procedure to be followed.

The secretary announced that a note of appreciation had been received from Mrs. Ralph E. Nolan, for the floral remembrance sent for the funeral of her husband, who died suddenly on July 28, 1940.

The speaker of the evening, Harry Harmon, Federal Procurement Officer for the State of Georgia, was then introduced, and gave an interesting talk on the details of federal purchasing, which proved instructive to the audience, judging from the questions put to Mr. Harmon. Following the discussion the meeting was adjourned.

S. Franklin Gardner Dies of Heart Attack

S. Franklin Gardner, a member of the Society since 1911, died suddenly at his home, 4901 Hillbrook Lane, N. W., Washington, D. C., on August 29, 1940, at the age of 62.

Mr. Gardner was born in Boston, and after finishing at Boston High School, entered Massachusetts Institute of Technology, receiving his S.B. in 1900. Following his graduation he moved to Washington and served five years as heating and ventilating draftsman in the architect's office of the United States Treasury, and later in the Department of Agriculture as mechanical engineer.

In 1909, Mr. Gardner and E. J. Ewing, and another associate, formed the Standard Engineering Co., Inc., of which he was president at the time of his death.

Besides being a member of the ASHVE and the Washington Chapter, he was affiliated with the *Heating, Piping and Air Conditioning Contractors National Association,* and was a past president of the District of Columbia Association, also a member of the Washington Lions Club, the Shrine, and a charter member of the Columbia Country Club.

He is survived by his widow, Mrs. Nora B. Gardner, two daughters, Florence L. and Dorothy M.; and two brothers and two sisters, to whom the Officers and Council of the Society extend their sincere sympathy.

Funeral services were conducted at the Hines Funeral Home on August 31, and burial was in Cedar Hill Cemetery.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month

28 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge the members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by November 15, 1940, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
BIRKETT, HAROLD S., Sup. Engr., Brooklyn Union Gas Co., Brooklyn, N. Y.	E. D. Milener	P. B. Gordon
BLAIR, DONALD W., Steam Service Engr., Boston Edison Co., Boston, Mass.	John James	W. E. Heibel
BRANDT, ALLEN D., P. A. Sanitary Engineer, U. S. Public Health Service, National Institute of Health, Bethesda, Md.	R. M. Nee	W. A. McPherson
CALNAN, EDWARD J., Power Engr., Ontario Paper Co., Ltd., Thorold, Ont., Can.	H. M. Tarr	James Holt
CUMMISKEY, JEROME F., Sales Engr., Minneapolis Honeywell Regulator Co., Minneapolis, Minn.	P. Drinker	J. Bloomfield (*Non-Member*)
CUSHING, R. C., Sales Engr., Minneapolis Honeywell Regulator Co., San Francisco, Calif.	C. P. Yaglou	R. Page (*Non-Member*)
DELAUREAL, W. D., Air Cond. Sales Engr., Fairbanks Morse & Co., New Orleans, La.	H. R. Roth	H. G. Hill
DICK, HAROLD, Refrigeration Serviceman, S. & S. Refrigeration, Jersey City, N. J.	E. A. Allcut	E. J. Davis
GAMMILL, O. E., JR., Sales Engr., Carrier Corp., New Orleans, La. (*Advancement*)	W. A. Ouweneel	W. F. Boden
GEZARI, ZVI, Mechanic, Adams Engrg. Co., New York, N. Y.	O. A. Trostel	C. W. Miller
HELWICK, N. J., Secy. & Engr., American Htg. & Plbg. Co., Inc., New Orleans, La. (*Advancement*)	C. E. Bentley	G. M. Simonson
HUGHES, SAMUEL, Estimator, Minneapolis Gas Light Co., Minneapolis, Minn.	C. L. Peterson	J. A. Hill
KEEFER, DONALD M., Htg. Engr., Jackson & Blanc, San Diego, Calif.	T. H. Bean (*Non-Member*)	G. E. May
KELSEY, HAROLD D., Engr., General Electric Co., Bloomfield, N. J.	L. V. Cressy	F. G. Burns
KILLEEN, E. F., Sales Engr., Shedlov Oil Burners, Inc., Minneapolis, Minn. (*Reinstatement*)	M. C. Giannini	S. K. Barrett (*ASME*)
LARAUS, JULIUS, Engr., Jowein, Inc., Jamaica, L. I., N. Y.	P. B. Gordon	F. L. Singer (*ASME*)
LAVORGNA, MICHAEL L., Sales Engr., L. J. Mueller Furnace Co., Milwaukee, Wis.	E. T. Murphy	W. H. Carrier
LONDON, MAURICE, Gen. Mgr., S. & L. Engrg. Co., Brookyln, N. Y.	L. L. Lewis	J. I. Lyle
MCCORMICK, GEORGE W., JR., Sales Engr., Morgan-Gerrish Co., Minneapolis, Minn.	M. C. Giannini	W. R. Bryans (*ASME*)
MCCULLEY, D. E., Mfrs. Repr., Omaha, Neb. (*Reinstatement*)	P. B. Gordon	C. E. Gus (*ASME*)
MILLS, DANIEL M., Repr., F. J. Evans Engrg. Co., Houston, Tex.	G. E. May	F. G. Burns
NICOLS, JOHN A., Dist. Mgr., B. F. Sturtevant Co., Western Div., Inc., Minneapolis, Minn.	J. J. Friedler, Jr.	L. V. Cressy
NUSBAUM, S. RICHARD, Mgr., Pennsylvania Engineering Co., Philadelphia, Pa.	A. B. Algren	R. T. Haley
PETERSEN, ROBERT H., Student, University of Minnesota, Minneapolis, Minn.	H. C. Mills	C. E. Lund
RAMSEUR, VARDRY D., JR., Htg. Engr., Ramseur Roofing Co., Greenville, S. C.	O. K. Wahrenbrock	T. J. Lords (*Non-Member*)
STURM, WILLIAM, Draftsman, Gausman & Moore, St. Paul, Minn. (*Reinstatement*)	C. R. Moe (*Non-Member*)	C. B. Sadler
SULLIVAN, TIM J., Pres., Sullivan Valve & Engrg. Co., Butte, Mont. (*Reinstatement*)	E. D. Harrington	F. H. Faust
VOLK, GEORGE H., Student, University of Wisconsin, Milwaukee, Wisconsin.	R. U. Berry	D. W. McLenegan
	M. H. Bjerken	H. S. Shedlov (*Non-Member*)
	Wm. McNamara	F. H. Schernbeck
	Irwin Jalonack	W. H. C. Lehman (*ASME*)
	H. S. Dutcher	William Sider (*Non-Member*)
	J. H. Volk	C. S. Becker
	W. A. Ouweneel	C. W. Miller
	W. R. Fidelius	L. J. Wachs
	R. F. Ruggles	J. A. Finnerty
	G. C. Morgan	B. P. Bredesen
	H. E. Gerrish	Wm. McNamara
	Frederick Organ	W. R. White
	Henry Kleinkauf	M. S. Tapley
	A. B. Banowsky	C. A. McKinney
	G. D. Maves	E. N. Pettit, Jr.
	C. E. Gausman	F. C. Winterer
	F. H. Schernbeck	Wm. McNamara
	C. S. Leopold	H. B. Prewitt
	F. H. Buzzard	E. H. Dafter
	Wm. McNamara	A. B. Algren
	C. P. Petersen	C. E. Lund
	T. H. Smoot	R. L. Allen (*SPEE*)
	R. L. Sweigert (*ASME*)	R. S. King (*ASME*)
	C. E. Gausman	F. C. Winterer
	Wm. McNamara	F. H. Schernbeck
	E. N. McDonnell	Bert Williams (*Non-Member*)
	B. V. McCune	H. E. Gerrish
	G. L. Larson	J. W. McKee
	D. W. Nelson	C. W. Miller

CANDIDATES ELECTED

In the past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBERS

WRIGHT, JOHN BERNARD, Sales Engr., Nash Engrg. Co., South Norwalk, Conn.

ASSOCIATES

BALL, FREDERICK THOMAS, Mgr., Stoker, Refrigeration Depts., Canadian Fairbanks-Morse Co., Ltd., Winnipeg, Man., Can.

HOLLAND, WILLIAM T., Engr., Heating, Piping and Air Conditioning Contractors, Milwaukee Assn., Milwaukee, Wis.

RICHARDS, LESLIE V., Owner, Richards Oil Burner Sales & Service, Malden, Mass.

SCHLICK, PAUL F., Br. Mgr., Grinnell Co., Inc., St. Paul, Minn.

JUNIORS

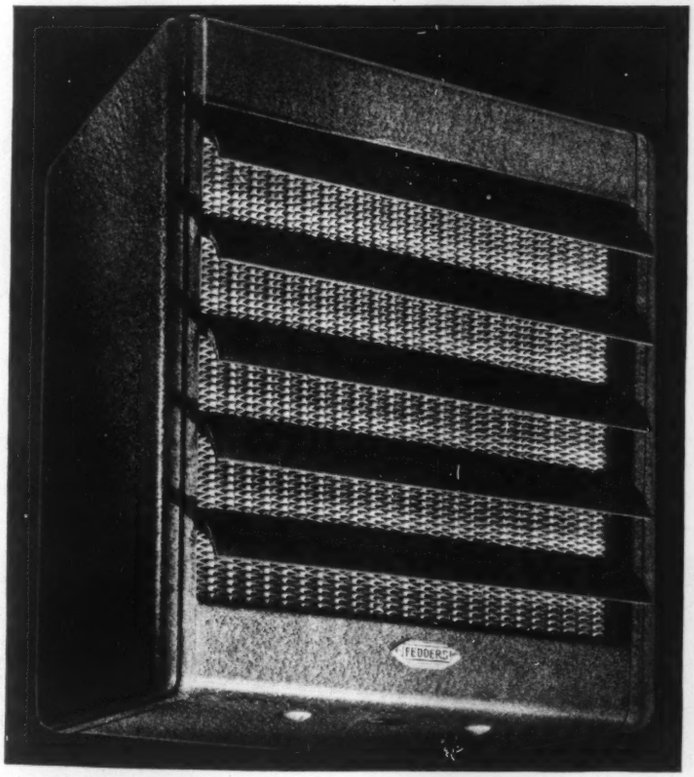
BERRYMAN, RICHARD H., Air Cond. Engr., Boyd-Cooper Htg. Co., Detroit, Mich.

PETERSEN, BRUCE W., Engr., Twin City Furnace & Appliance Co., Minneapolis, Minn.

Built for men who

APPRECIATE GOOD DESIGN

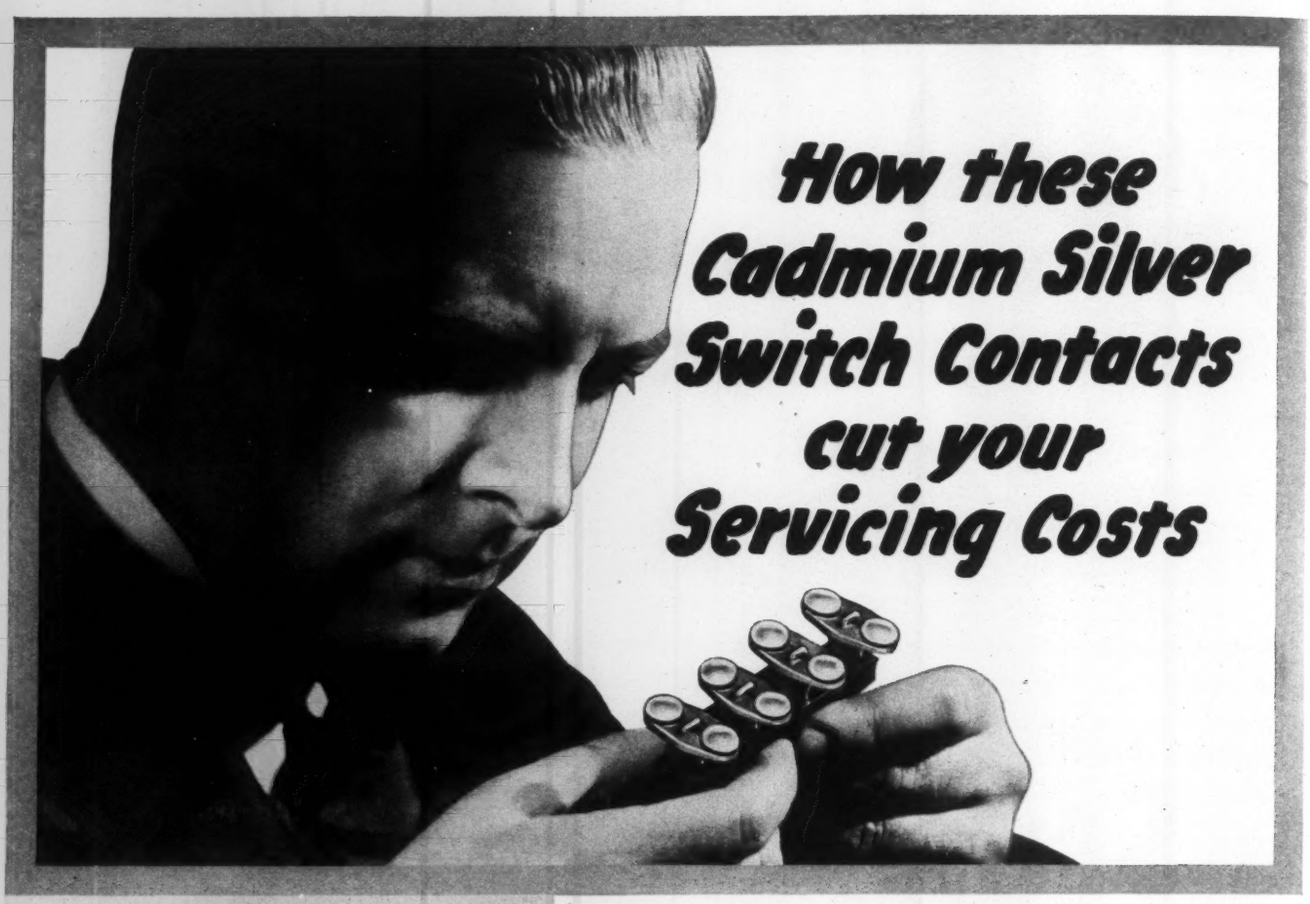
SERIES 4 UNIT HEATERS



1. **STREAMLINE TUBES** with individual non-clogging fins relieve differential expansion stresses between adjacent tubes.
2. **FULL FLOATING** protection against expansion stresses between heating element and cabinet.
3. **MONO-PIECE CABINETS** combine strength, rigidity and handsome appearance for commercial and industrial uses.
4. **HEADERS** are of large internal area for uniform steam distribution.
5. **MOTORS** are mounted in rubber to isolate vibration.

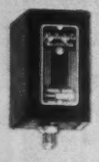
Write for Catalog 573.

FEDDERS
MANUFACTURING CO., INC.
Air Conditioning Division
81 Tonawanda St. Buffalo, N. Y.
Representatives in all Principal Cities



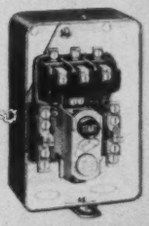
For Trouble-Free Operation Specify A-B Motor Control

D-C Relay Bulletin 200—For oil furnaces, refrigerators, etc. All types.

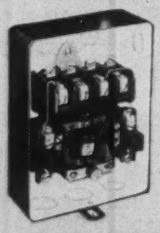


Temperature Control Bulletin 836—Pressure and temperature control switch.

A-C Relay Bulletin 700—A compact, inexpensive, reliable switch unit.



Hand-Operated Starter Bulletin 609—A rugged, across-the-line switch. Provides motor protection, trouble-free operation.



Automatic Solenoid Starter Bulletin 709—Remote control for squirrel-cage motors. Solenoid switch assures reliable operation.

Allen-Bradley Company

A-B

1335 S. First St. Milwaukee

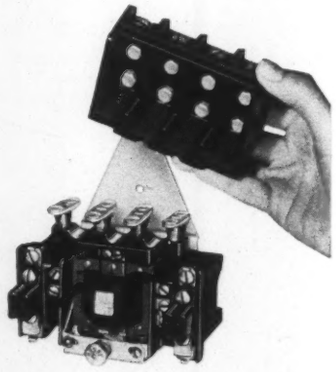
The chief source of motor control trouble is "contacts." You can eliminate this trouble, and thus cut servicing costs on your heating, air conditioning, and refrigeration installations, by specifying motor control equipped with double break, cadmium silver contacts (exclusive with Allen-Bradley). Note their three advantages:

1 - No Contact Maintenance

These contacts never need cleaning or filing. They are at all times in perfect operating condition.

2 - Longer Contact Life Because it is not necessary to file away contact life as with copper contacts, Allen-Bradley contacts provide longer service.

3 - Greater Interrupting Capacity The deionizing effect of the cadmium silver contacts combined with the enclosed arc hood snuffs the arc out instantly.

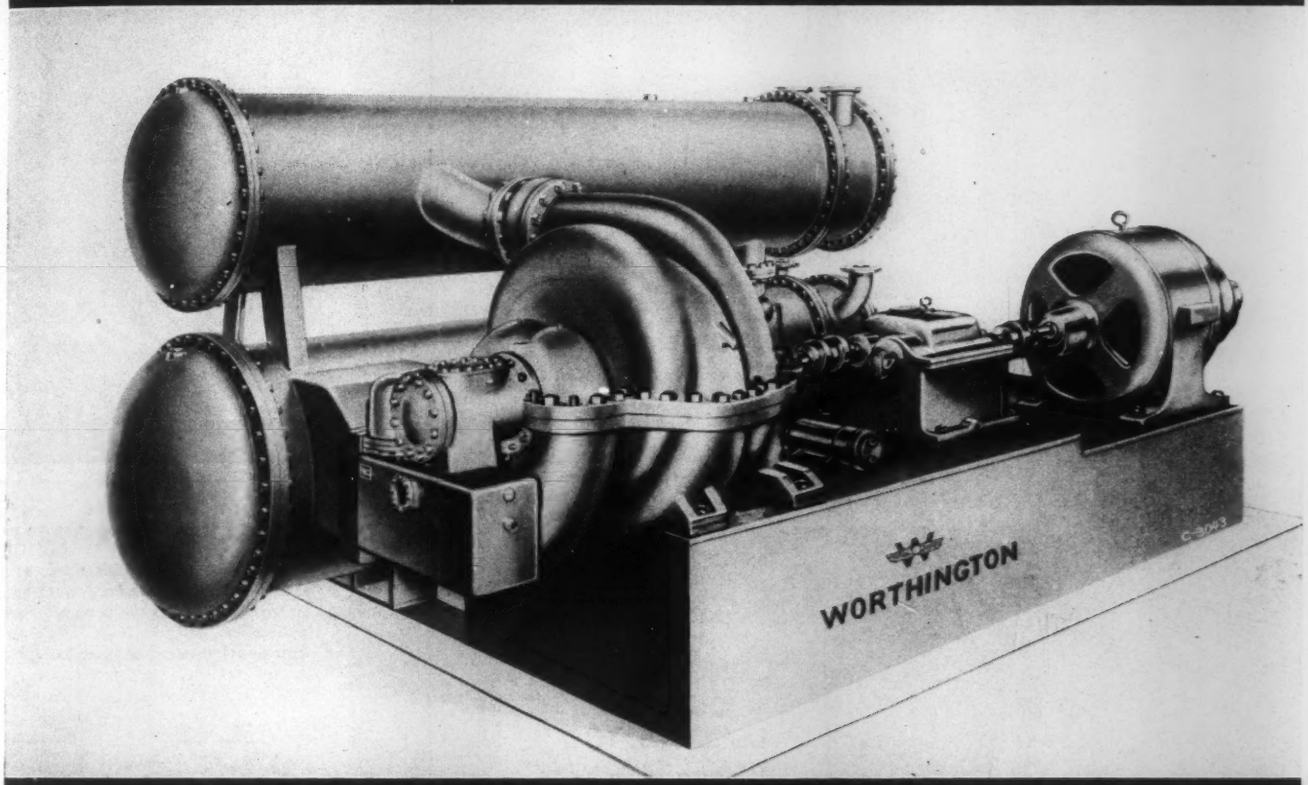


Size 1 solenoid switch structure with arc hood lifted off to show the cadmium silver contacts.

ALLEN-BRADLEY
SOLENOID MOTOR CONTROL

READY to speed up production of many vital elements of the Defense Program

WORTHINGTON *CENTRIFUGAL* COMPRESSORS



FOR AIR CONDITIONING AND REFRIGERATION

42 UNIT SIZES . . . 150 to 650 tons

PRODUCTION of many of the tools and equipment items for the military and naval services calls for working conditions made possible only by air conditioning . . . uniform temperature to eliminate variations from the expansion and contraction of metals in precision parts . . . humidity control to guard against tarnishing of polished surfaces . . . a comfortable healthful atmosphere to keep workers at top effectiveness.

Worthington builds air conditioning and refrigeration equipment of all types, to meet any condition. Newest and highest in efficiency, for large tonnage requirements, are the systems incorporating centrifugal refrigeration compressors.

Tell us your production problems as they relate to air conditioning and refrigeration. A Worthington recommendation will furnish a sound basis for their solution.

CARBONDALE DIVISION • WORTHINGTON PUMP AND MACHINERY CORPORATION
General Offices • HARRISON, NEW JERSEY • *Offices and Representatives in Principal Cities*

WORTHINGTON

CAO-19

"IT'S

"IT'S SO EASY TO HANG AND TO INSTALL"

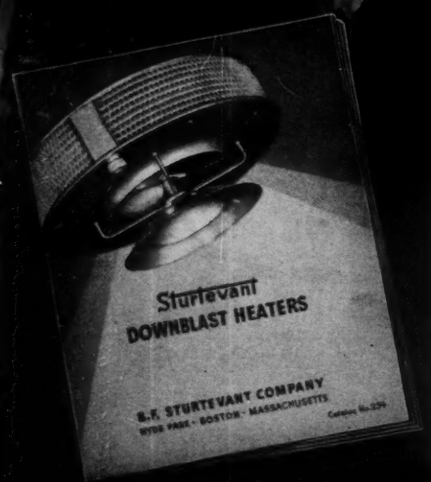
Very simple piping requirements, because steam lines can be connected to whichever side is most convenient. 4 punched hanger-holes permit hanging in either direction.

"GETS HEAT DOWN FASTER"

Where a heater must be placed at considerable height because of a crane or other obstruction, the Downblast Speed Heater forces heat down faster—more effectively.

"USING THEM IN OUR NEW BUILDING, TOO"

This is just one of the heating problems that Downblast Speed Heaters have licked. They are never in the way—even in plants where equipment would obstruct the flow of heat from other types of heating units.



IT'S NOT TOO LATE!

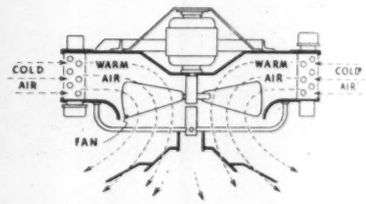
. . . to plan a remedy for last winter's cold spots and draft-swept areas. You can install Sturtevant Downblast Speed Heaters now—without interrupting plant routine—and get the heat down just where it's needed.

Our Downblast Heater Bulletin gives range of sizes, capacities, installation data and complete information. Use the coupon on the opposite page for your copy.

Check THESE ADVANTAGES

1. HEAT WHERE WANTED

In congested areas, increased velocity of Downblast Speed Heaters projects heat directly from the fan to the working level, where equipment or partitions might otherwise obstruct circulation of heated air.

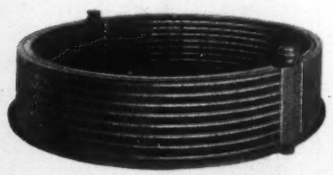


2. LESS HEAT WASTE

. . . because a downblast, instead of a horizontal or slightly downward angle, permits installing the heater much higher—thus recirculating heat otherwise wasted in upper areas.

3. HIGH HEATING EFFICIENCY

Circular heating element utilizes finned copper tubes *brazed* into two headers—for maximum radiating surface. Even expansion and even temperature are assured by headers on either side of the coil.



4. QUIET, EFFICIENT FAN

Improved three-blade fan design made to exacting tolerances that assure perfect balance—maximum efficiency without vibration and with minimum noise. Resilient mounting of fully enclosed motor also contributes to quiet operation.

THE LAST WORD
in high velocity heating!"

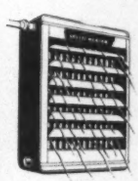
Sturtevant's "Downblast"
SPEED HEATER

Unit heaters have gained wide acceptance in industry by offering three major advantages over cast-iron radiation:—improved heating; adaptability; and fuel economy.

Now, with the introduction of Sturtevant's Downblast Speed Heater, incorporating many new advantages, you can get still further efficiency and flexibility—for the problem-areas of plant heating where high velocity heat projection is practical.

The Sturtevant Downblast Heater is particularly suited for use, under certain conditions, where heat must be projected downward from a considerable height. Downblast circulation throws a *Beam of Heat* at high velocity direct to the working area. Better circulation reduces the temperature difference between floor and ceiling—eliminates the cold layer of air often found on the floor level—and recirculates the high ceiling heat-layer which is otherwise wasted.

NOW—ALL THREE TYPES! Sturtevant makes three types of unit heaters—the conventional suspended and floor types, and the "Downblast" type featured in this advertisement—each of which has individual advantages for specific installation conditions. Sturtevant Engineers, therefore, are in a position to give you *unbiased* heating recommendations. Call on our 80 years of air engineering experience to help in the solution of your heating problems.



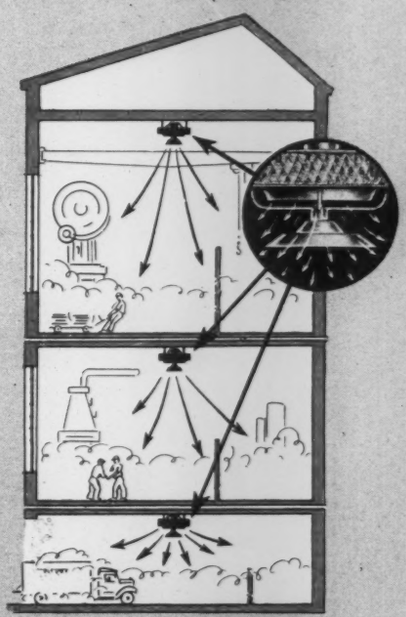
STURTEVANT SUSPENDED TYPE SPEED HEATER

B. F. STURTEVANT COMPANY
Hyde Park, Boston, Mass. Branch Offices in 40 other cities
B. F. Sturtevant Company of Canada, Ltd., Galt, Toronto, Montreal

STURTEVANT FLOOR TYPE MULTIVANE HEATER

ADJUSTABLE "THROW" for Various Ceiling Heights

Two removable Deflection Cones diffuse the heat evenly for varied installation conditions—and are standard equipment on all Downblast Speed Heaters.



See in the illustrations how Downblast Speed Heaters throw a beam of heat direct to the working level from ceilings as high as 40 feet. Note the ideal heat diffusion that results in more even temperatures — prevents accumulation of hot air in the upper areas.

Sturtevant
REG. U. S. PAT. OFF.
Puts Air to Work

MAIL THE COUPON—NOW!

B. F. STURTEVANT COMPANY HPAC 1140
Hyde Park, Boston, Mass.

I am interested in your New Downblast Speed Heater.

- ☐ Send me descriptive Bulletin No. 454.
- ☐ Send me the standard Speed Heater Catalog.
- ☐ Send me the Multivane Heater Catalog.
- ☐ Have your local Sales Engineer call.

*Name*_____ *Title*_____

*Company*_____ *Address*_____

Equipment DEVELOPMENTS

For your convenience in obtaining more information about any of this equipment, see coupon on this page. Add the new products and companies listed here to your Directory Section which you received in your January, 1940, HEATING, PIPING AND AIR CONDITIONING and thus keep your records of sources of supply up to date throughout the year . . . Single asterisk (*) indicates equipment not listed in Directory Section; double asterisk (**) equipment and manufacturer not listed

FOR YOUR CONVENIENCE

HEATING, PIPING AND AIR CONDITIONING, [11-40]
6 N. Michigan Ave., Chicago, Ill.

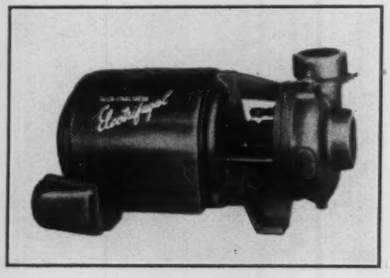
Please ask the manufacturers to send me more information about the equipment mentioned under the following reference numbers in "Equipment Developments" and "Recent Trade Literature." (Circle each number in which you are interested):

1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2000	2001	2002	2003	2004					
3684	3685	3686	3687	3688	3689	3690	3691	3692	3693
3694	3695	3696	3697	3698	3699	3700	3701	3702	3703
3704	3705	3706	3707	3708	3709	3710	3711		

Name .....Title.....
Company .....
Address .....
City .....State.....

Centrifugal Pump Unit

No. 1980—The new "Electrifugal" pump is an all-in-one centrifugal pump designed as a complete pump and motor unit on one shaft and one housing. It has a special motor with a one piece cast iron motor yoke and pump bracket. The feet are cast integral with the housing and bracket and extend under the entire unit instead of under the motor only. The motor design meets NEMA specifications for splashproof motors, it is stated.

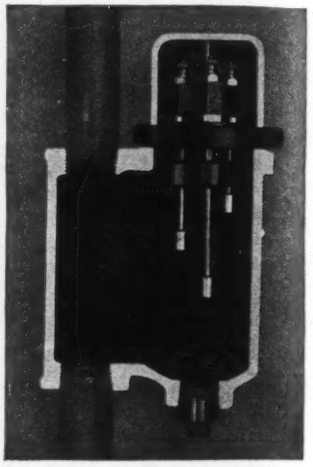


In splashproof construction this unit is available in sizes from one to 10 hp inclusive at 3500 rpm and from ¾ to 7½ hp inclusive at 1750 rpm for heads up to 160 ft, with larger sizes in process of design. For normal service the pump is built with cast iron casing, bronze fitted. It can, however, be made all iron, all bronze, or stainless steel, or other special metals to suit various industries.—Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Boiler Water Controls

No. 1981—For use on boiler feed systems where pumps are employed to return condensate or add make-up water, two new models of boiler water level control have been announced, one for use with electric pumps and the other for use with steam pumps. Their purpose is to maintain the boiler water at a safe, efficient level by starting the pumps whenever the water falls below the predetermined minimum, the maker says.

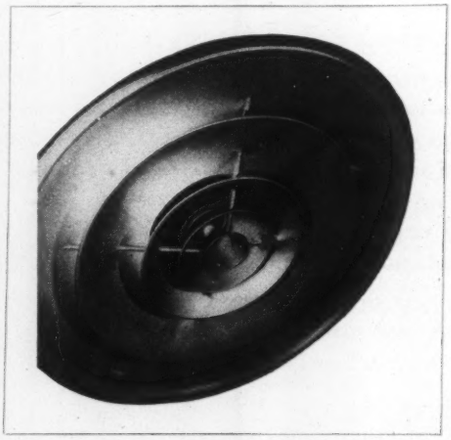
Each utilizes electrode control. Two electrodes of different lengths are suspended in a chamber which can be mounted on a water glass column. When the water level falls below the longer electrode an electrical circuit is disturbed which, through a relay, starts the pump, keeping it going until the water in the boiler reaches the short electrode. A third electrode can be provided to shut off the stoker, oil burner or gas burner in the event the pump fails and the water falls to a dangerous level.



The illustration shows an interior view of the electrode holder. It will be noted the design eliminates floats and moving parts.—Johnson Corp., 830 Wood St., Three Rivers, Mich.

Improved Air Diffuser

No. 1982—An improved "Type C" air diffuser has recently been announced, the improvements including a reduction of approximately one-third in the diameter of the outer cone, the addition of a substantial molded edge on the outer cone, and an increase in the diameter of the fixing stays. According to the maker, these improvements combine to increase ruggedness of construction, simplify the installation and make the unit even more attractive in appearance.



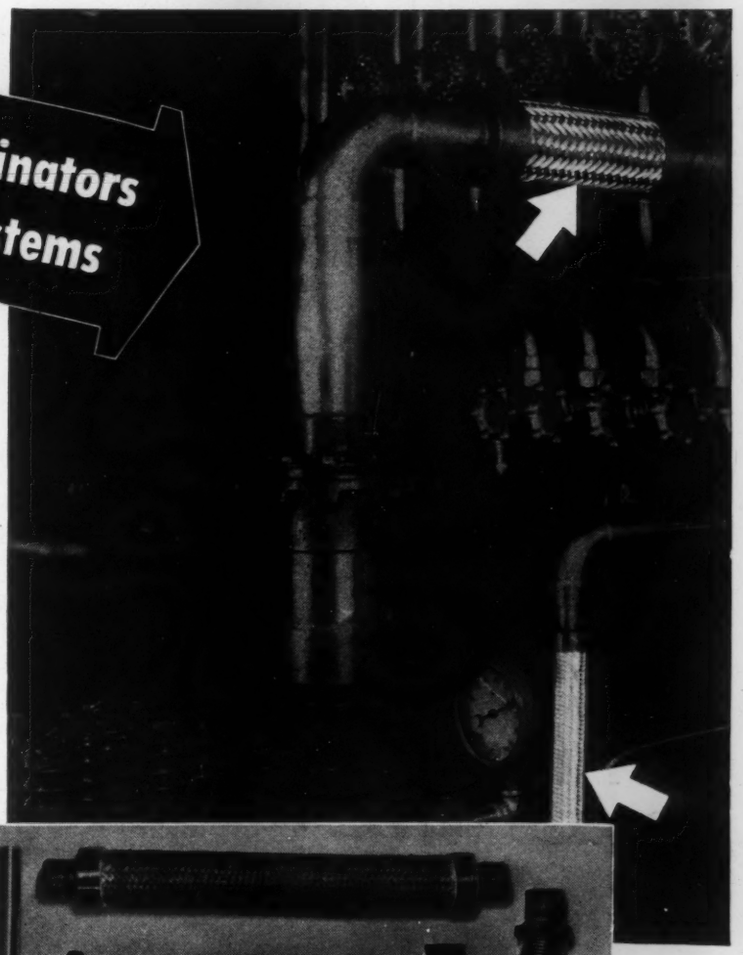
Because of the smaller outer dimension, the ceiling opening to receive the diffuser is correspondingly smaller which will permit installation between beams with a minimum of structural framing.

The molded edge is designed to prevent smudging and streaking of the ceiling under all but the most unfavorable conditions.

This type of air diffuser mounts flush with the ceiling and is generally used in commercial, institutional and residential air conditioning, air heating and ventilating installations.—Anemostat Corp. of America, 10 E. 39th St., New York, N. Y.

Whenever you need a flexible connector for liquids or gases, use

American Seamless Flexible Metal Tubing

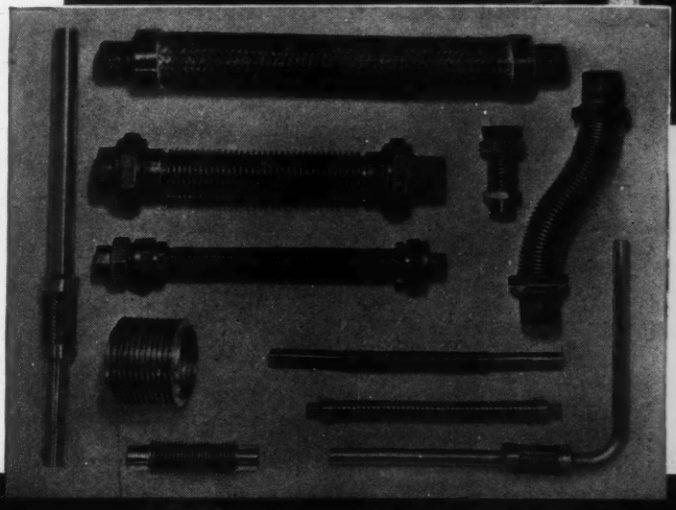


Example: Vibration Eliminators for air-conditioning systems

FOR permanent tightness in liquid or gas lines...for protection against breakage or leakage under constant flexing...for the elimination of excessive vibration, there's only one 100% correct answer to your problem. You need flexible tubing that's free of laps, seams, welds or joints of any kind. One that's made of strong, *seamless* metal tubes. And that means American Seamless Flexible Metal Tubing.

"American Seamless" is used regularly in thousands of applications for carrying steam, oil, air, liquids and gases for heating, cooling or lubricating machine parts that must move frequently; for absorbing vibration in rigid pipe lines; for quick and economical connection of misaligned parts.

When you have a flexible connector problem, put it up to our Engineering Department. Meanwhile, write for our new reference Catalog SS-25. 39237



RIGHT: *Just a few of the many hundreds of special flexible tubing assemblies that we have designed—each to perform a specific duty.*

American Metal Hose

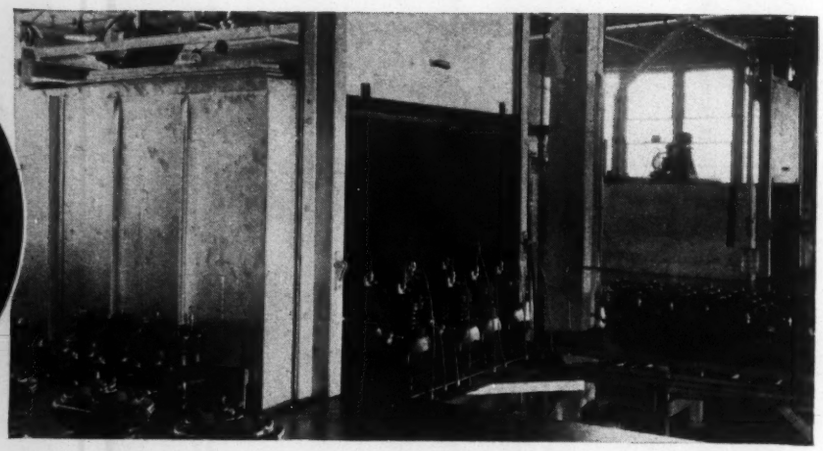
ANACONDA
from mine to consumer

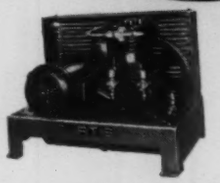
AMERICAN METAL HOSE BRANCH of THE AMERICAN BRASS COMPANY

General Offices: Waterbury, Conn. • Subsidiary of Anaconda Copper Mining Company

Tests that Assure You The Dependable, Low Cost Performance of

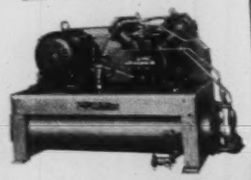
CURTIS Condensing Units





Above—1½ h.p. Air-Cooled Condensing Unit

Below—15 h.p. Cleanable Shell and Tube Condensing Unit



Dehydrating

Every compressor of every CURTIS condensing unit is given, not one, but two dehydrations in baking ovens under temperatures of 282 degrees F. First the compressor itself is thoroughly dehydrated and evacuated of foreign matter. Then after assembled into a unit the entire unit is again dehydrated and a vacuum of as high as 28" produced to insure the removal of any non-condensible gases or moisture which might have entered thru fittings during the assembly process.

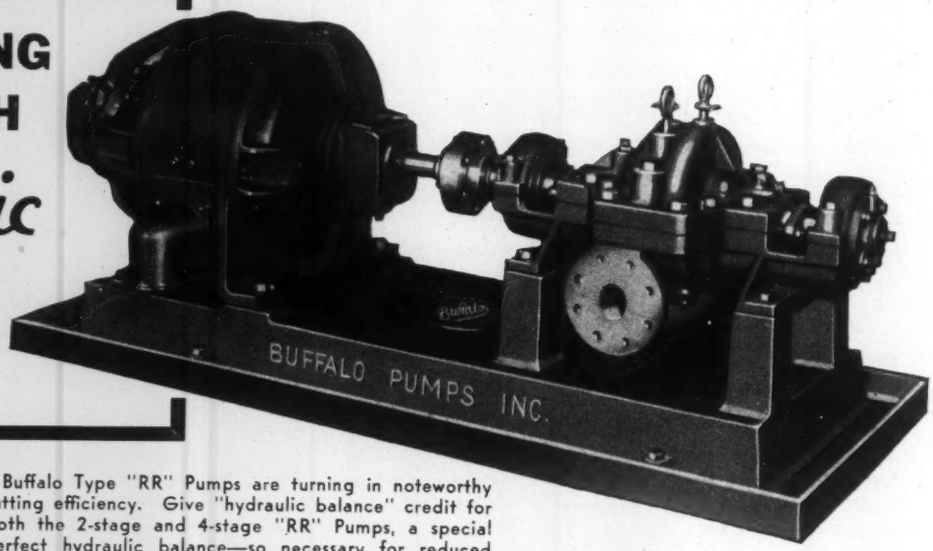
Thorough dehydration and cleaning is only one of many examples of the care and precision of Curtis manufacturing methods. The result is the exceptionally long life, high efficiency and care-free performance of every Curtis Condensing Unit.

Write for full information.

Curtis Refrigerating Machine Company
1950 Kienlen Avenue St. Louis, Missouri
Established 1854
Division of Curtis Manufacturing Co.

CURTIS REFRIGERATION AIR CONDITIONING and COMMERCIAL

CUT PUMPING COSTS WITH "hydraulic balance"



On boiler feed and general service, Buffalo Type "RR" Pumps are turning in noteworthy records for endurance and for cost-cutting efficiency. Give "hydraulic balance" credit for its share of this performance! In both the 2-stage and 4-stage "RR" Pumps, a special Buffalo design assures practically perfect hydraulic balance—so necessary for reduced vibration and stepped-up efficiency. Better get ALL the details on this outstanding Buffalo Pump!

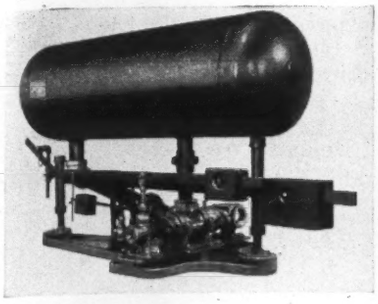
BUFFALO PUMPS, INC.
171 Mortimer Buffalo, N. Y.
Branch Engineering Offices in Principal Cities
Canada Pumps, Ltd., Kitchener, Ont.

WRITE:
Bulletin 980 gives complete engineering data on Buffalo Type "RR" Pumps. Send for your copy today.

"Buffalo" SINGLE SUCTION • MULTI-STAGE • TYPE "RR" • PUMPS

Boiler Feeding and Deaerating Systems

No. 1983**—An important function of a new automatic system for steam drainage and boiler feeding is its ability to deaerate water fed to boilers, the manufacturer points out, as oxygen and non-condensable gases are detrimental to metal under heat and pressure.



Design of the equalizer emphasizes new features in the rocker section, which bears the brunt of mechanical operation, it is stated. The naval bronze female trunnion receives direct support from a bearing unit composed of two split bearings cast integrally to insure permanent alignment and located in the center of the rocker section, thus carrying the full load of the tilting mechanism. No weight rests on the packing.

Other structural features include large stuffing boxes with split packing glands held by T head bolts, "Alemite" fittings for lubricating bearings and packing, heavy galvanized steel tank, dirt-proof bumpers and union tank connections.—W. M. Acker Organization, Inc., 3167 Fulton Rd., Cleveland, Ohio.

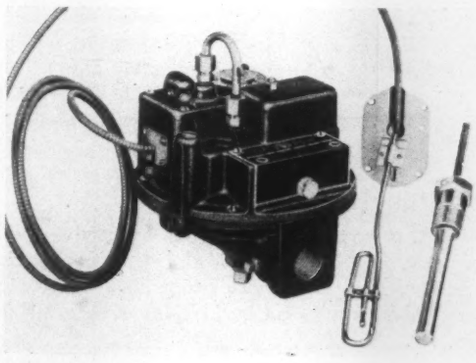
Bearings Reclassified

No. 1984—In order to obviate difficulties in trying to distinguish between the series numbers assigned to various types of anti-friction bearing units, one manufacturer is humanizing the presentation of its five types by comparing them with prize fighters and reclassifying the group on this basis. The five types are the Series 100 ball bearings, and the 400, 500 and 600 and 7200 self-aligning roller bearings. The new classifications are the "flyweight," "welterweight," "middleweight," "heavyweight" and "alternate heavyweight," respectively.

The whole line is to be known as the "Friction Fighter" bearings.—Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill.

Diaphragm Gas Valve

No. 1985—A recently announced development combines a diaphragm gas valve and a "hydraulic action" mechanical limit



PIONEERING ILG LEADERSHIP

"Firsts"

NUMBER 6 OF A SERIES

Patented

"FLOATED DRIVE" BRACKETS FOR ILG UNIVERSAL BLOWERS

Another ILG pioneering "first"! With motor mounting riding on flexible rubber cushions, possibility of noise and vibration of metal to metal contacts can be completely isolated in ILG Universal Blowers by the exclusive "Floated Drive" Bracket. No complicated mechanism—just by mounting the standard ILG motor bracket in a second "floating" bracket or ring which is isolated from the blower housing by rubber cushions, a highly effective dampening of possible sound and vibration is accomplished. Helpful to this design is ILG's direct-connection of motor and wheel which permits isolation of BOTH motor and wheel as a single unit.

OTHER ILG "Firsts"

- ★ Placed direct-connected propeller fans on production basis—1906
- ★ Popularized direct-connected blowers—patented 1910
- ★ Variable air control for blowers—1926
- ★ Type C (condenser-type) Motors—1925
- ★ Penthouses or power roof ventilators—1915
- ★ Automatic shutter—1907
- ★ Motor operated shutter—1918
- ★ Solenoid operated shutter—1907
- ★ Propeller fan steam unit heater—1916.
- ★ Self-contained electric unit heater—1917
- ★ ILG ATTIC system of summer cooling—1918
- ★ Portable type kitchen ventilating fans—1918
- ★ Built-in type kitchen ventilating fans—1925
- ★ Transom type kitchen ventilating fans—1925

NO WONDER ENGINEERS WHO "KNOW" ALWAYS SPECIFY ILG "FIRST"

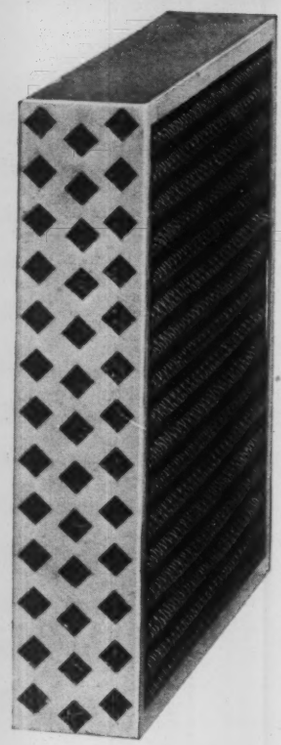
- ★ Supremely quiet operation
- ★ No unbalanced cushioning
- ★ No amplification of sound by blower housing
- ★ Four-point vertical floating of weight
- ★ Available for all model ILG Blowers as extra equipment
- ★ Write today for Catalog No. EB-381

ILG ELECTRIC VENTILATING CO.
2841 N. CRAWFORD AVENUE, CHICAGO, ILL.
Offices in 42 Principal Cities

ILG

Vitalized VENTILATION
AND AIR CONDITIONING
*AIR CHANGE...NOT JUST AIR MOVEMENT!

Protect . . .
YOUR SYSTEM
AND ITS PERFORMANCE
WITH
AIR-MAZE
permanent
AIR FILTERS



You protect your air conditioning system investment in more ways than one when you install AIR-MAZE permanent filter panels. In the first place, you insure *top notch performance.* Not even the finest dust and grit can get through, yet the flow of clean, pure air is unrestricted.

The blower and motor, too, are protected against unnecessary "drag" due to clogged filter areas. AIR-MAZE filter panels will not clog, and they have greater dust holding capacity than ordinary filters.

AIR-MAZE panels are fire retardant—*approved as such by the Underwriters' Laboratories,* an important form of protection. There's also protection against the tendency to use clogged and inefficient filters too long in order to "save cost of replacements." AIR-MAZE panels are permanent,—no replacements are needed. They can be thoroughly cleaned in a jiffy for new-like performance, thus paying for themselves many times over during the life of your equipment. AIR-MAZE panels are all-metal, sturdy, odorless and ready to slip into existing panel spaces.

WRITE FOR LATEST CATALOG

Air-Maze filter panels can be furnished in standard or in any special sizes and shapes to meet unusual applications. Write for latest catalog or special information.

AIR-MAZE CORPORATION
5200 HARVARD AVE - - - CLEVELAND, OHIO

AIR-MAZE
CLEANABLE AIR FILTER PANELS

control into one compact unit. The built-in limit control simplifies installation by eliminating three-way interconnections between limit and valve plus the problem of extra servicing, the manufacturer states. Normal operation of the limit control is not affected by electrical power failure or by normal opening of the valve.

The valve is of the puff bleed type to provide almost instantaneous shut-off of bleed upon burner ignition, and has an automatic recycling feature.—White-Rodgers Electric Co., 1209 Cass Ave., St. Louis, Mo.

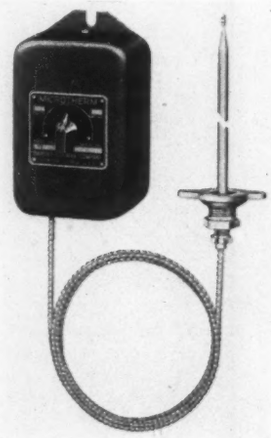
Unit Heater of Radial Design

No. 1986—The new radial unit heater design provides wide and uniform distribution of heated air in factories, according to the manufacturer, who states that one of these units can be used in place of two or more single direction heaters in order to reduce installation costs.

This new unit heater is made in one style for suspension only and is encased in a semi-circular steel casing finished in brown baked-on wrinkled enamel. It is made in seven cabinet sizes and in 22 capacities, ranging from 41,690 to 476,000 Btu per hr.—McQuay, Inc., 1600 Broadway, N. E., Minneapolis, Minn.

Remote Bulb Thermostat

No. 1987—Illustrated here is a new remote bulb thermostat—known as the remote bulb "Microtherm"—for proportioning control. According to the manufacturer, it brings the advantages of the "Micro" control system to situations where the requirements call for a motor operated valve or damper to be positioned accurately and quickly in accordance with load variations. Applications include air conditioners, hot water tanks, dryers, etc.



The remote bulb and bellows assembly are hydraulically formed and the volume of liquid and conducting surfaces are balanced for maximum sensitivity and dependability with minimum ambient temperature effect. The bulb is furnished with a mounting flange suitable for either immersion or duct mounting. The mechanism is enclosed in a black crinkle finish metal case with a tight fitting cover.

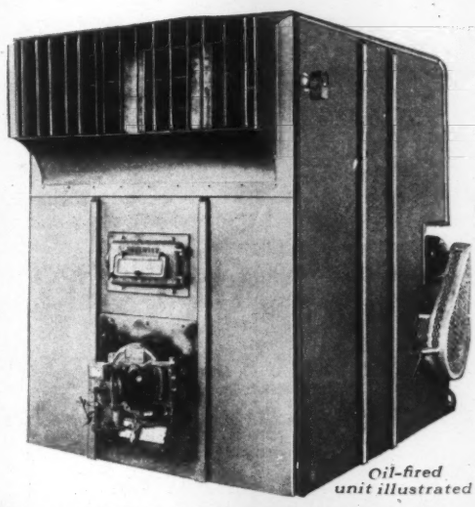
Thermostats for two-position control (with snap acting contacts) and for floating control are also available.—Barber-Colman Co., 225 Loomis St., Rockford, Ill.

Block and Pipe Insulation

No. 1988—A new 1500 F insulating material called "L-W Superex" is furnished in both block and pipe covering form for use as an insulation in the service temperature range above 600 F, on power plant equipment and piping industrial furnaces, flues, stacks, etc.

• You Can Amortize The Cost of This Warm Air Heating Plant in a Minimum of Time

The Directherm, Direct-Fired Warm Air Unit Heater For Plants of All Types



Oil-fired unit illustrated

300,000 to 1,500,000 BTU CAPACITY

- **DIRECTHERM WARM AIR HEATERS FOR OIL, GAS OR COAL** are available in six standard sizes with capacity from 300,000 to 1,500,000 Btu's. They are made of heavy gauge steel plate, with major sections all welded and flue gas headers are readily cleanable.
- **VENTILATION AND AIR RE-CIRCULATION.** The Directherm can be easily hooked up for outside air intake. Air filters may be used in the intake box when desired.
- **INSTALLATION.** These units, when assembled, require nothing more than a stack and an electrical connection (plus a gas or oil fuel hook-up) and can be made fully automatic in operation when using oil, gas or stoker.
- **PORTABILITY.** Directherm Heaters may be readily removed from one location to another or from one plant to another when building expansion programs demand such alterations in the heating system.
- **LOW INSTALLATION AND OPERATING COSTS.** Because of their low first cost, the investment in Directherm Warm Air Heaters can be amortized in a minimum of time and are thus particularly desirable for plants of possible semi-permanent utility. High efficiency of combustion with discharge of heat direct from the unit makes for low heating cost.

LEADING ARCHITECTS AND ENGINEERS

Endorse Warm Air Heating For Plants. The Directherm Warm Air Unit is ideal for industrial heating and will meet the requirements demanded of the new tendency to designate warm air installations for plant heating.

- **DUCT WORK.** While the Directherm Heater will provide thorough heat distribution without duct work, where necessity requires it may be hooked up with a system for further heat distribution. The fan equipment is of ample capacity to overcome duct resistances.

Factory Representatives. A few territories still open. Write for details.

ORDER NOW FOR PROMPT DELIVERY

AIRTHERM MANUFACTURING COMPANY

712 S. SPRING AVE. • • ST. LOUIS, MO.

TO INSURE PRECISE TEMPERATURE CONTROL

Economical and precise control of temperature in modern air conditioning is dependent upon the efficiency and ADEQUACY of low-temperature insulation. Mundet Cork Insulation should be applied to air ducts, pipe lines, refrigeration equipment and all places where heat infiltration might occur.

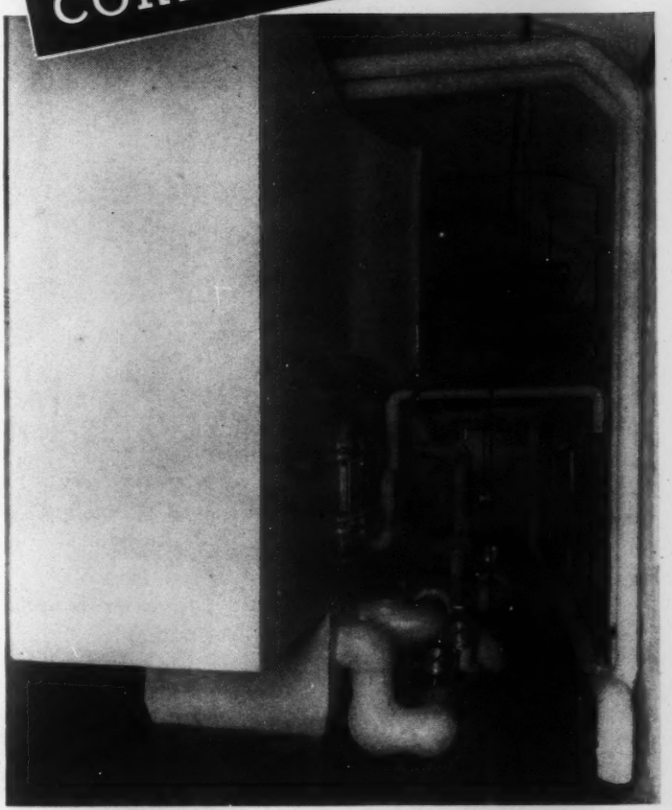
Fabricated from pure cork, by the most improved methods, Mundet Corkboard and Moulded Cork Pipe Covering are guaranteed to give long and highly efficient service. To insure this performance, we offer Mundet Contract Installation, thru which all details of construction are arranged.

Mundet offices in principal cities give prompt and responsible service. For suggestions and estimates covering the application of Mundet Cork Insulation, write to Mundet Cork Corporation, Insulation Division, 65 S. Eleventh St., Brooklyn, N. Y.

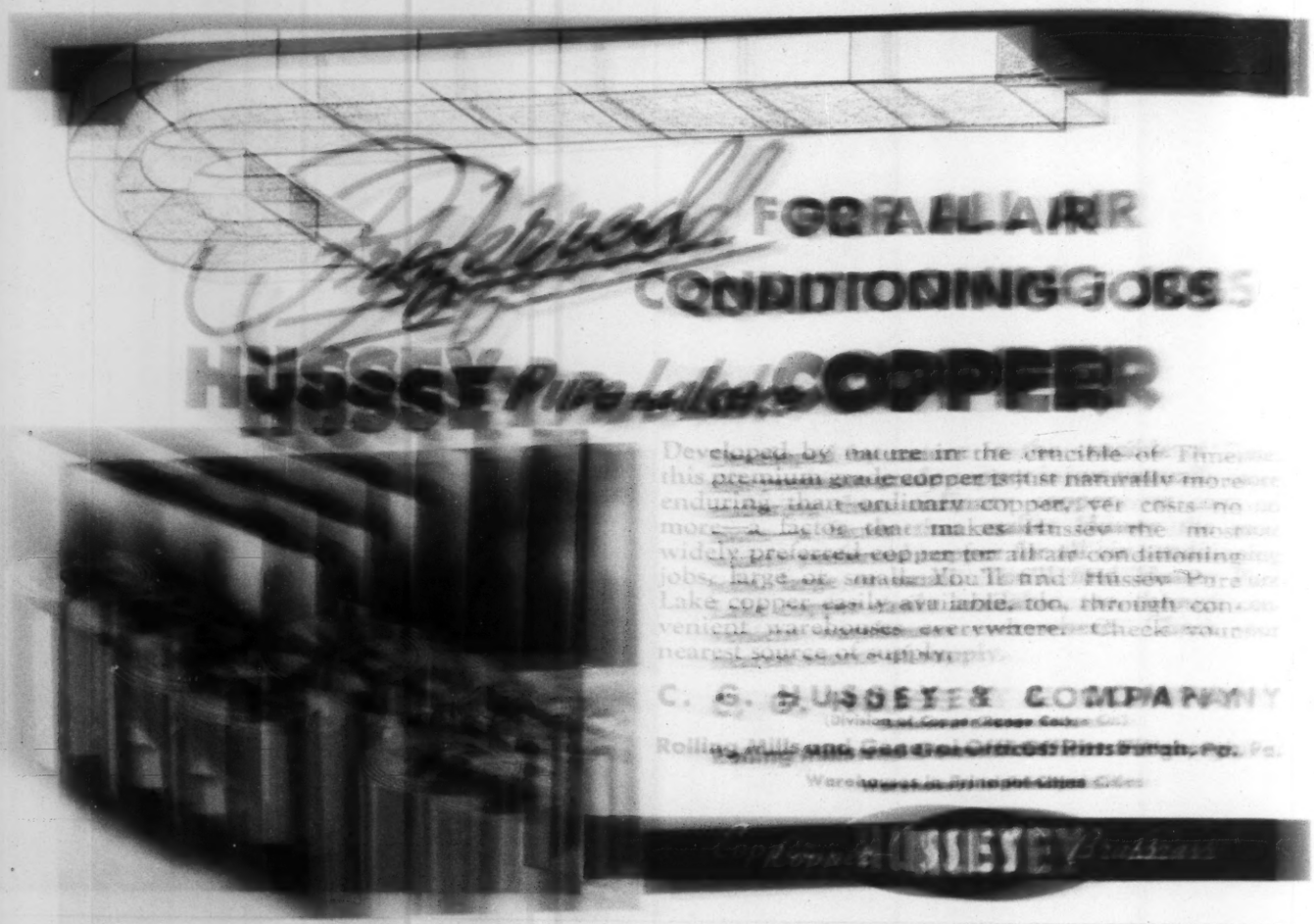
● *PREVENT VIBRATION TROUBLES by specifying Mundet Natural Cork Mats for fan foundations and motor mounts. Description sent promptly.*

FOR ALL LOW-TEMPERATURE

MUNDET CORK INSULATION



Mundet Cork Insulation protects this air washer and pipe lines in the U. S. Marine Hospital, Savannah, Ga.



Developed by nature in the crucible of Time, this premium grade copper is just naturally more enduring than ordinary copper, ever costs no more. A factor that makes Hussey the most widely preferred copper for all air conditioning jobs, large or small. You'll find Hussey Pure Lake copper easily available, too, through convenient warehouses everywhere. Check your nearest source of supply.

C. G. HUSSEY & COMPANY

Rolling Mills and General Offices: Pittsburgh, Pa.

Warehouses in Principal Cities

For Underground or Overhead Steam Lines

Made Possible Only by Approved Modern Engineering

The Ric-wil Co., Cleveland, Ohio

Agents in Principal Cities

RIC-WIL

It is of the molded diatomaceous silica type and weighs 20 lb per cu ft. Blocks are furnished in various weights and thicknesses and are also available in curved form. The pipe insulation is supplied to fit standard pipe sizes in sections or segments 3 ft long and up to 2½ in. thick.—Johns-Manville, 22 E. 40th St., New York, N. Y.

Direct Current Motors

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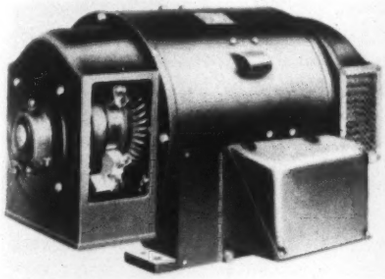

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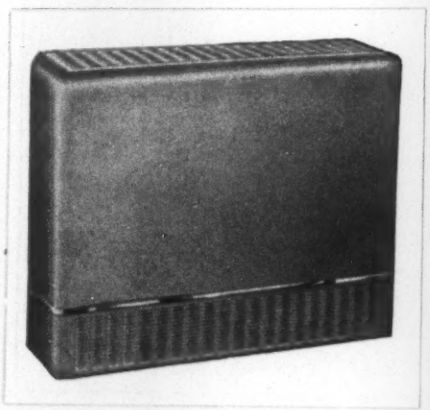
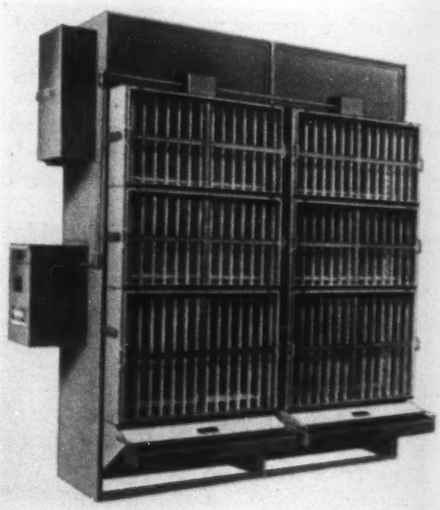


It is made in three styles — wall type, floor type and suspended—and is available in eight sizes. Each unit has two quiet operating fans.—McQuay, Inc., 1600 Broadway, N. E., Minneapolis, Minn.



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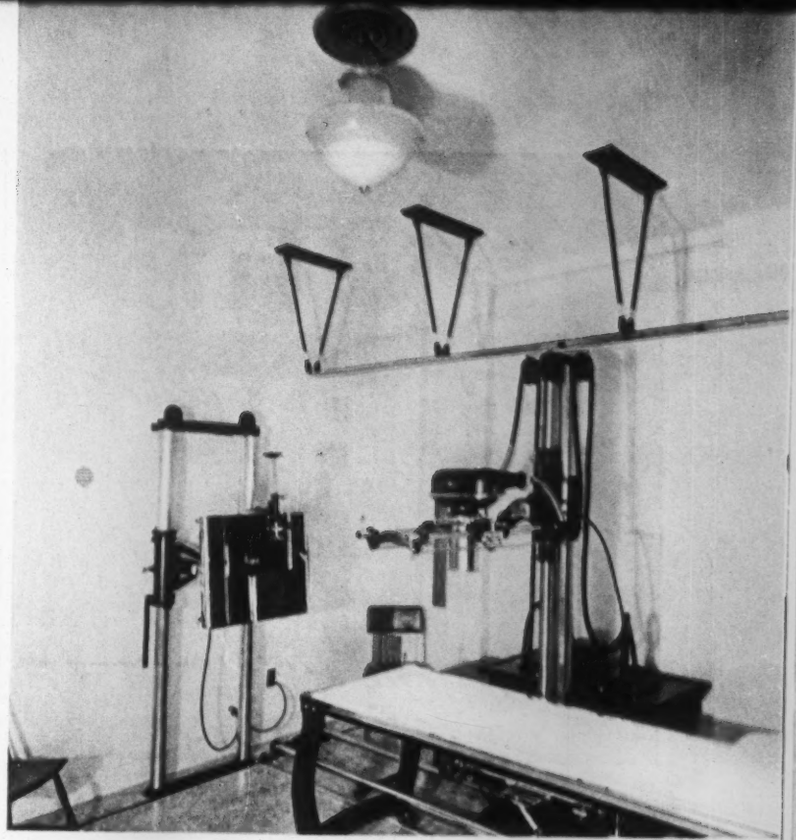
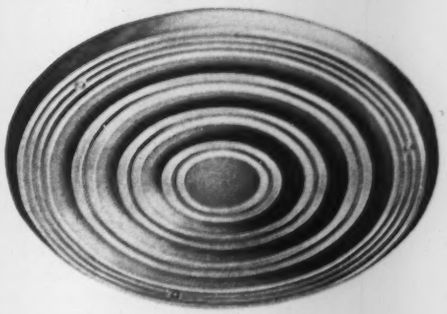
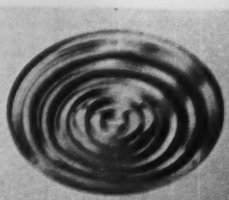


AEROFUSE OUTLET

IS EASILY COMBINED WITH
ANY TYPE LIGHTING FIXTURE



Notice the air of quiet efficiency about the Ex-Ray Room above. The Aerofuse Outlet has been easily combined with the special lighting fixture demanded. Just as easily — just as naturally it lends itself to combination with almost any type of fixture and becomes an unobtrusive part of the decorative plan. But functional superiority is the great reason for the fast growing popularity of the Aerofuse Outlet. Efficiently it provides, (1) Maximum Air Mixture, (2) Rapid Temperature Equalization, (3) Perfect Air Distribution, (4) Total Elimination of Drafts.



. . . . And Now
A SUPPLY AND RETURN UNIT

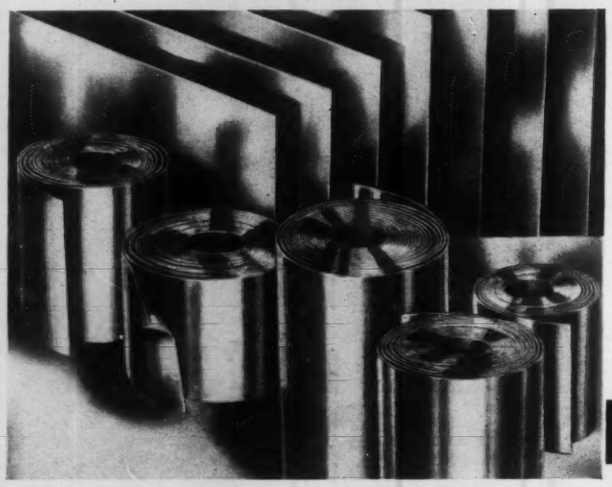
Valuable in installations where simplification of the duct layout is of primary importance. Supply and return (exhaust) ducts can be run to the same point.

T & B

TUTTLE & BAILEY, Inc.
NEW BRITAIN, CONN.
NEW YORK CHICAGO PHILADELPHIA

Preferred FOR ALL AIR CONDITIONING JOBS

HUSSEY *Pure Lake* COPPER



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C. G. HUSSEY & COMPANY
(Division of Copper Range Co.)
Rolling Mills and General Offices: Pittsburgh, Pa.
Warehouses in Principal Cities

Copper **HUSSEY** *Brass*

For Underground or Overhead Steam Lines

Insulated PIPE UNITS

Asphalt of Quality and "Life"
Protects a Strong Pure Iron
Shell of Precision Pre-Fabrication by Armco.
Unique—Strong—Dependable!
Made Possible Only by Approved Modern Engineering

Any lengths up to 50 ft. Pre-fabricated units include steam pipe, insulation, and all accessories—nothing else to buy! Any standard pipe covering may be specified, or any hand molded insulation—or, for highest efficiency, genuine Dry-paC Waterproof Asbestos. Only ONE thing to specify—only ONE thing to buy! Speed of installation and satisfactory service are fully assured.

Trained Ric-wiL representatives are available on your underground steam problems. Write now for Unit Bulletin No. 4013.

The Ric-wiL Co., Cleveland, Ohio
Agents in Principal Cities

Ric-wiL

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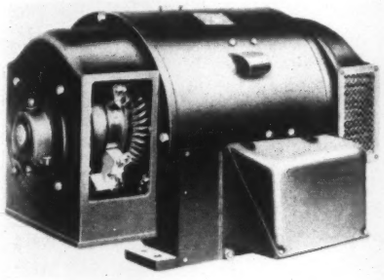

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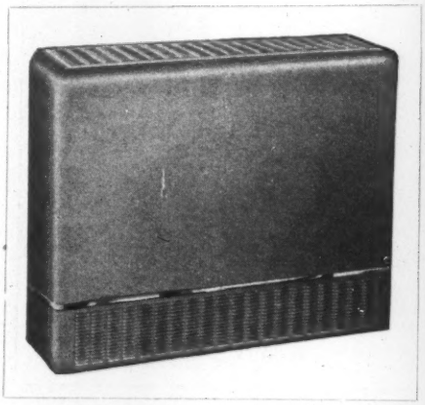

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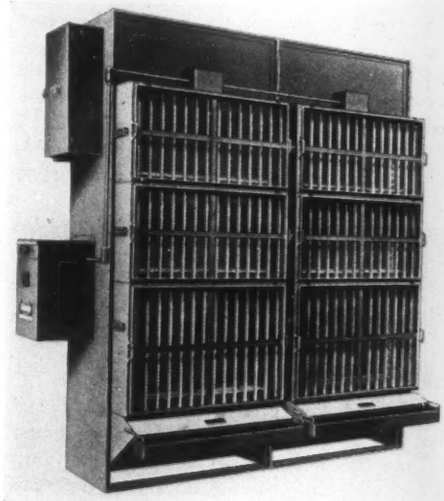
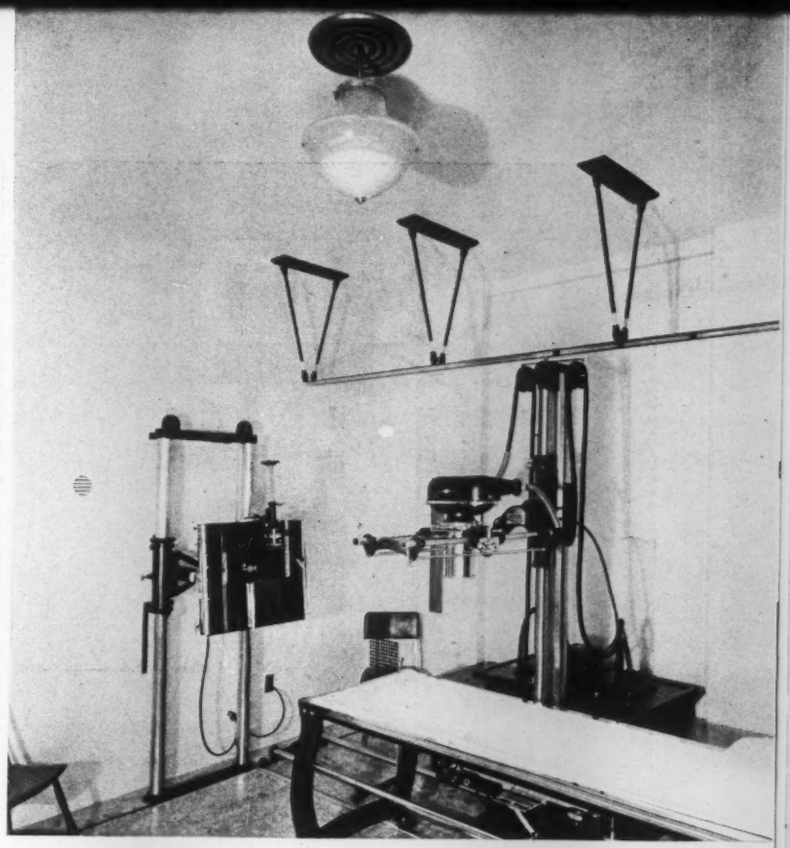


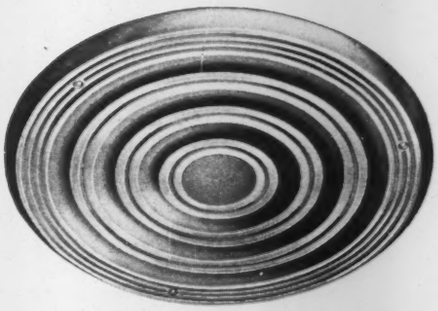
Automatic Air Filter

No. 1991—The new "American" automatic air filter, which recently went into regular production, replaces the "Multi-Panel" and "Double Duty" constructions. The new casing has been designed so that either armored



AEROFUSE OUTLET

IS EASILY COMBINED WITH ANY TYPE LIGHTING FIXTURE



Notice the air of quiet efficiency about the Ex-Ray Room above. The Aerofuse Outlet has been easily combined with the special lighting fixture demanded. Just as easily—just as naturally it lends itself to combination with almost any type of fixture and becomes an unobtrusive part of the decorative plan. But functional superiority is the great reason for the fast growing popularity of the Aerofuse Outlet. Efficiently it provides, (1) Maximum Air Mixture, (2) Rapid Temperature Equalization, (3) Perfect Air Distribution, (4) Total Elimination of Drafts.

. . . . And Now

A SUPPLY AND RETURN UNIT

Valuable in installations where simplification of the duct layout is of primary importance. Supply and return (exhaust) ducts can be run to the same point.

T & B

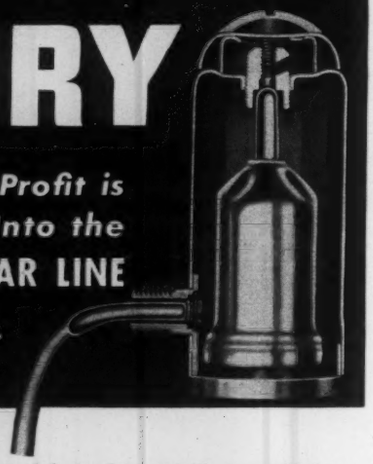
TUTTLE & BAILEY, Inc.

NEW BRITAIN, CONN

NEW YORK CHICAGO PHILADELPHIA

INSIDE STORY

Shows How Profit is Engineered Into the **DOLE ALL-STAR LINE** *For You*



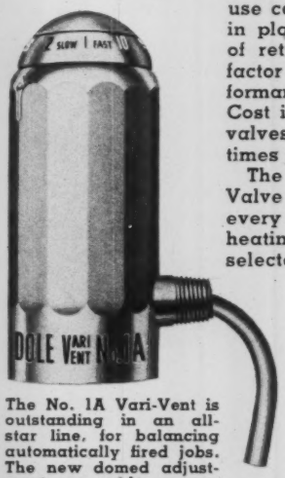
What the customer sees of Dole Air and Vacuum Valves is designed to attract, and that's a profit angle—But, INSIDE, they are engineered to perform, and that's for greater profit. And, that's why Dole is known as an All-Star Line—Each valve in this fast moving line is a star performer in the position for which it was designed. Modern practice dictates many special conditions.

Wide Variation of Modern Requirements

First, automatically-fired heating systems and hand-fired systems set up two broad sets of conditions to meet. Then, each may be open or closed, requiring air or vacuum valves—and each may use convectors, pipe coils or unit heaters in place of standard radiators. Venting of return lines and mains is a special factor in all systems and there again performance will depend on the valves used. Cost is another angle, where a range of valves on another price level can sometimes turn loss to profit on a job.

The complete Dole Air and Vacuum Valve line assures top performance on every variation or combination of these heating conditions. Every valve is easily selected for its particular job, quickly installed, unlikely to need service (and guaranteed if it does).

Let your jobber suggest a representative stock. Write direct for details of an attractive new display counter.



The No. 1A Vari-Vent is outstanding in an all-star line, for balancing automatically fired jobs. The new domed adjustment cap adds eye-appeal—improves venting.

THE DOLE VALVE COMPANY
1901-41 Carroll Ave., Chicago, Ill.
Offices and Representatives in all Principal Cities

DOLE
Air and Vacuum
VALVES

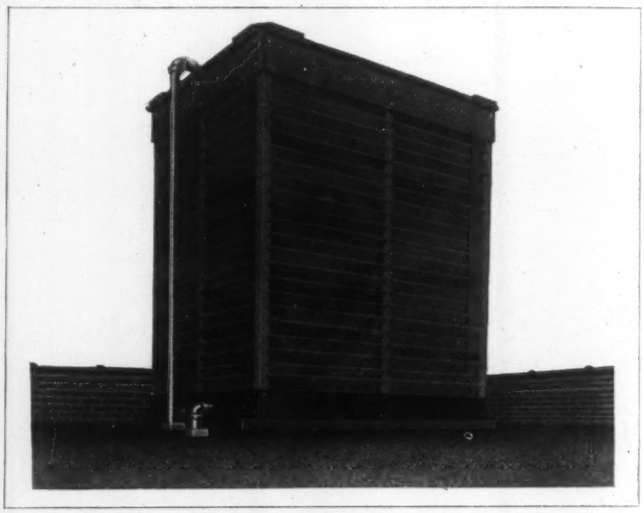
screen panels or die stamped louver panels can be used for the filter curtains. The new automatic filter with armored screen panels has the same performance characteristics as the "Multi-Panel" units, and the louver panels are identical with the "Double Duty."

In making this change to simplify this line of automatic filters, it was decided to standardize on the section heights and widths selected for the "Electro-Matic" (illustrated) filter. The designation numbers for height and width are now the same for all of the manufacturer's curtain type self-cleaning filters, but the over-all dimensions of the automatic filter are different from those of either the "Multi-Panel" or "Double Duty."

The interchangeability of panels is made possible by a newly designed curtain channel guide which is adjustable to any thickness of filter curtain. The panels may be interchanged at any time should it be necessary to meet changing operating conditions.—American Air Filter Co., Inc., 107 Central Ave., Louisville, Ky.

Natural Draft Cooling Towers

No. 1992—The new "Series 100" natural draft cooling towers were developed with the primary aim of economy in water saving equipment, yet they offer the advantages of experienced engineering, factory production, immediate delivery from stock, a welded steel basin and complete guarantee as to quality, durability and performance, the maker states. The towers are completely shop fabricated so that no piece requires any further fitting or drilling and none is needed in addition to those supplied. The parts furnished have only to be bolted together, the unit being shipped knocked down.



Only three pipe connections are required, one to the spray header at the top, one to the float valve in the basin, and another from the return outlet.

Heart California redwood louver posts constitute the main upright framework of the tower and these are bolted at the base to the steel basin side walls and at the top to the horizontal frame members. The louver boards, also Heart California redwood, are "slip-fitted" into position and held without any rigid permanent fastenings.

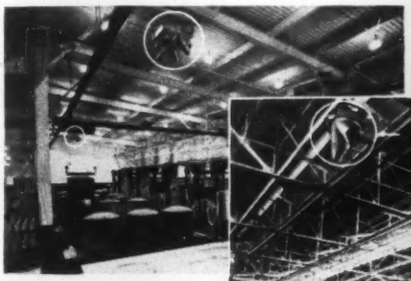
Capacities in tons of refrigeration, based on a 3 mph broadside wind and 250 Btu per min per ton to be dissipated by the cooling tower, and for 75 F wet bulb temperature and 85 F cold water temperature, range from 3.7 to 37.0 tons.—Marley Co., 3001 Fairfax Rd., Kansas City, Kans.

Multi-Point Indicator

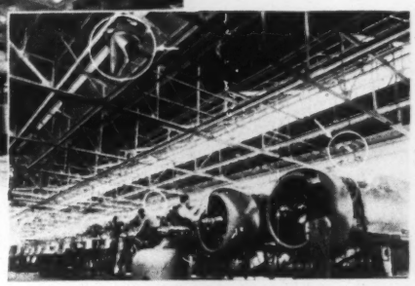
No. 1993—For indicating drafts, pressures, differentials, and other factors in boiler and industrial furnace operation, a new multi-point indicator has been placed on the market. Zero adjustments and all piping connections for each gage unit are

WINGS for American Industry

THE AIR AT CEILING IS DRAWN THROUGH HEATING ELEMENT AND PROJECTED THROUGH REVOLVING DISCHARGE OUTLETS TO WORKING LEVEL
WING
DISCHARGE→OUTLETS→REVOLVE→SLOWLY



Left: Some of the 116 WING Unit Heaters at Wright Aeronautical Plant, Paterson, N. J.



Right: Curtiss-Wright Plant, Buffalo, N. Y., has installed 43 WING Heaters

As defense production schedules speed up, plant heating becomes more important, for comfortably heated factories mean greater employee efficiency.

WING Unit Heaters assure uniform comfort . . . . no uneven distribution of heat . . . . no hot and cold spots . . . . thoroughly uniform heat distribution.

The new Revolving Discharge Heater gives a refinement in heat distribution not heretofore attainable; workers experience new heating comfort—a sensation of live, invigorating warmth.

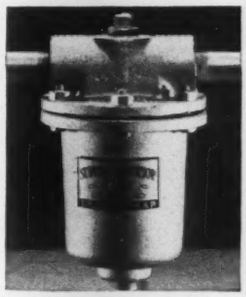
This is the result of nearly 20 years of continuing improvement on the "Floodlight" System originated by WING in 1921.

WING Unit Heater Bulletin H-8 contains installation diagrams, piping details and other interesting engineering data. Write for your copy now.

L. J. WING MFG. CO., 14th St. & 7th Ave., NEW YORK, N. Y.
Works: Newark, N. J. *Montreal, Canada*

WING REVOLVING DISCHARGE UNIT HEATERS

Straight-line trapping *STOPS "DETOUR" PIPING*



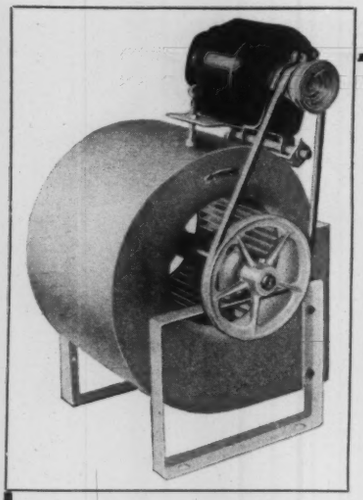
● Straight-line piping of inverted bucket steam traps signalizes the end of wasteful, time-consuming "Detours." Such waste is no longer necessary—the modern Anderson Super-Silvertop design makes "detour" piping out of date. This **engineered** steam trap simplifies the trapping, for piping with Super-Silvertop is quick—saves fittings and labor—is neater in appearance. Installed either straight-in-line or as an elbow, Super-Silvertop requires no extra fittings and you save as much as an hour of installation time per trap.

The guided, bucket-on-a-trap design of Anderson Super-Silvertop steam trap insures constant, perfect parts alignment. Longer lever arm gives greater condensate capacity and trap is easily inspected without disturbing pipe connections.

Get the complete story—send for your copy of "How To Choose a Steam Trap"—write to—

THE V. D. ANDERSON CO.
1934 West 96th Street • Cleveland, Ohio

Super-Silvertop Steam Traps



Especially Designed to Meet your Needs!

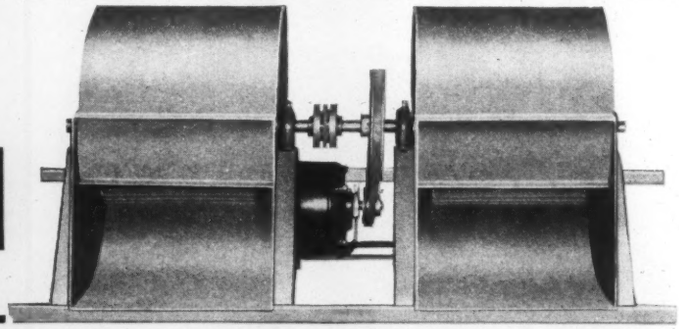
Your requirements for forced-air equipment may be rigid, but the REX line of blowers is highly flexible. From its wide range of styles and sizes selection for a specific purpose is easy. Furthermore, years of experience in designing and building special blowers for manufacturers and contractors qualifies our engineers to recommend blower designs without prejudice in favor of our standard units. Let us quote on REX Blowers for your 1941 conditioners and thus prove the statement at the head of this advertisement to your complete satisfaction.

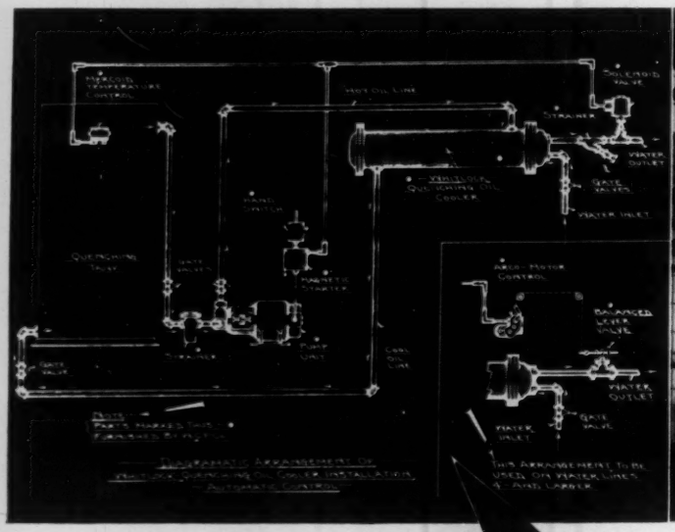
1941 CATALOG READY SOON
WRITE FOR YOUR COPY

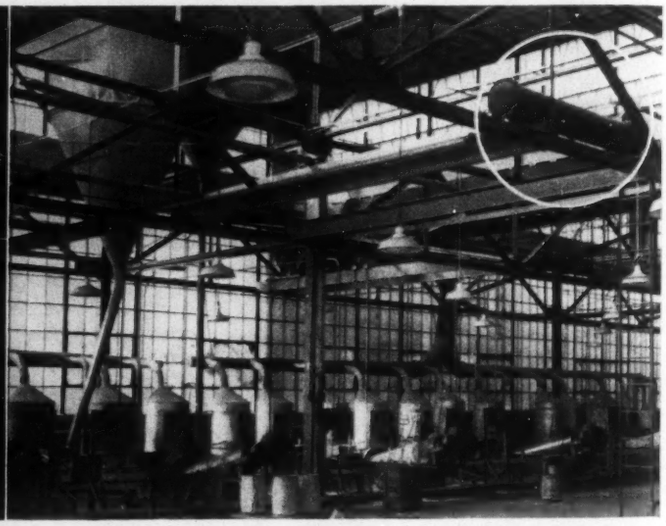
Air CONTROLS INC
Div. of
The Cleveland Heater Co.

1934 W. 114th St., Cleveland, Ohio

REX BLOWERS







For QUENCHING OIL COOLERS in Heat Treatment of Steel, Specify

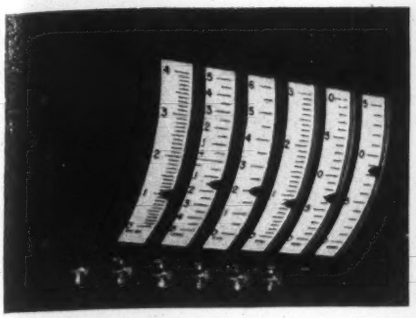
WHITLOCK

Keeping quenching oil uniformly at the correct temperature is vitally important in securing consistent results in the heat treatment of steel. The best method of doing this—practically and economically—is by circulating the quenching oil from the top of the tank through a Whitlock Quenching Oil Cooler and back to the tank again.

For engineering recommendations, or for copy of Bulletin 101 which illustrates types of Coolers furnished and tabulates sizes required for various oil temperature ranges and quantities of steel, address—

The Whitlock Manufacturing Co.
44 South St., Elmwood, Hartford, Conn.

District offices in New York, Boston, Chicago, Philadelphia, Detroit, Richmond.

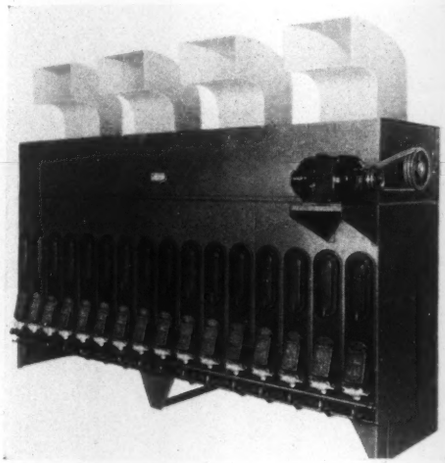


accessible from the front of the panel and each unit is designed to be withdrawn, like a book from a shelf, without disturbing other units.

Each gage is actuated by a sensitive dry-bellows type of diaphragm for ranges from 0 to 50 in. of water or by a helical element for pressures above 50 in. of water. The gages have 12 in. vertical, translucent, rear illuminated scales. The new indicator is supplied with from two to 16 of these interchangeable gage units, and is built for either flush or projected mounting.—Republic Flow Meters Co., 2240 Diversey Pkwy., Chicago, Ill.

Gas Fired Unit Heaters

No. 1994—A new gas fired unit heater, particularly suited to large space heating requirements of factories, warehouses, auditoriums, hangars and similar buildings—and adaptable to industrial uses such as drying—has been announced. The floor type is illustrated and a suspended type is also available.

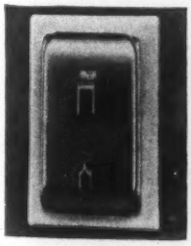


Due to its sectional design, the unit may be operated with full air volume for distribution and but a portion of the heating sections in operation to secure uniform temperature control in mild weather. A safety pilot is used in each section and thermostatic control of the unit may be employed.

The units are available in a large range of sizes, from an AGA input rating of 270,000 to 1,080,000 Btu.—L. J. Mueller Furnace Co., 2005 W. Oklahoma Ave., Milwaukee, Wis.

New Thermostats

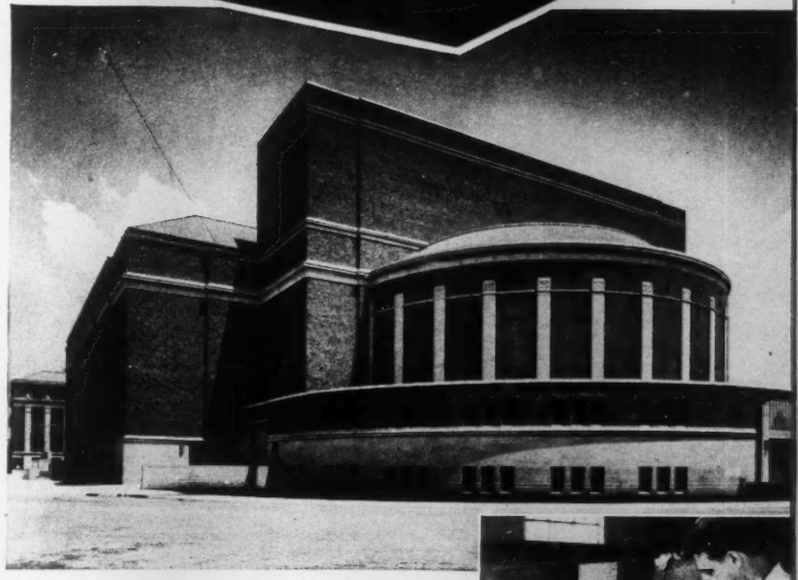
No. 1995—The new "T-80" series of thermostats includes a regular thermostat, a thermometer-thermostat and a timer-thermostat. According to the manufacturer, the most interesting of the improvements is the unobtrusiveness of the parallel design and that they extend but 13/16 in. off the wall. The units are designed to obtain a flush mounted appearance but are actually surface mounted on a wall-harmonizing plastic base of neutral color. The thermostat itself has a dull chrome finish, and only two mounting screw holes and a ¼ in. control cable opening are necessary in the wall.



The plastic base is said to act as a blanket to thermally isolate the thermostat from the wall so that it will respond better to conditions in the room.

Solos or Symphonies—
NOISE in DUCTS
CAN'T SPOIL THEM

All air-conditioning ducts in Purdue University's new Hall of Music quieted with this durable, fire-safe, sound-absorbent lining—J-M AIRACOUSTIC SHEETS



J-M AIRACOUSTIC SHEETS are supplied in large, relatively lightweight units that are easily handled . . . quickly installed at low cost.

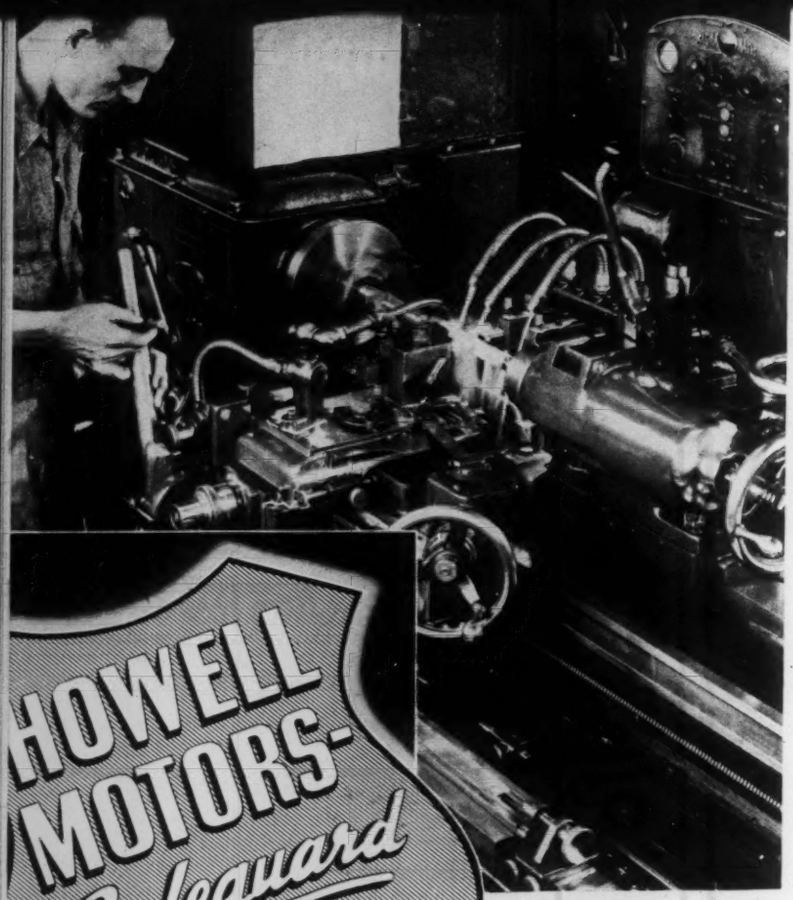
IN planning this beautiful new Hall of Music at Purdue University, architect Walter Scholer made sure that noise in air-conditioning ducts would never be a nuisance. All such ducts were lined with J-M Airacoustic Sheets.

More than 70% sound-absorbent, this modern duct lining effectively prevents disturbing noise from being carried by ducts . . . adds extra quiet to rooms. Because Airacoustic Sheets are basically mineral—can't support flame—they introduce no fire hazard. And J-M Airacoustic Sheets are unusually strong, durable and moisture-resistant in service.

Quick and easy to install, Airacoustic Sheets add so little to the cost of any air-conditioning job you can include duct-quieting in every estimate. For details, write for brochure AC-23A. Johns-Manville, 22 East 40th Street, New York, N. Y.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville
AIRACOUSTIC SHEETS FOR DUCT LININGS



HOWELL MOTORS—Safeguard Your Conditioning Installations

EXAMPLES OF PRECISION

One in a Series of Advertisements, "HOWELL Motors in the Making" — showing how modern precision standards maintain HOWELL quality. . . .

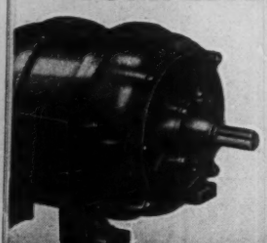
Even Shafts Are Finished to *Extremely Close* Limits . . .

All shafts for HOWELL Motors are machined as shown in the photograph above, using automatic lathes of the most modern type. So accurate is this operation that, in the final grinding which follows, shafts can be held to within tolerances of .0003 inches.

Shaft, rotor, bearings, stator — every part of a HOWELL Motor is built to such precision standards that for all practical purposes VIBRATION IS ELIMINATED.

And when you conquer vibration, you also conquer noise! ***In fact, HOWELL Motors are so QUIET-RUNNING that they measure up to the MOST exacting demands on this score.***

COMPLETE LINE — FAST DELIVERY



For 25 years HOWELL has specialized on polyphase motors for air conditioning, ventilating and heating drives. Motors can be furnished with any electrical and mechanical characteristics required — sizes range from ½ to 150 HP, single or multi-speed.

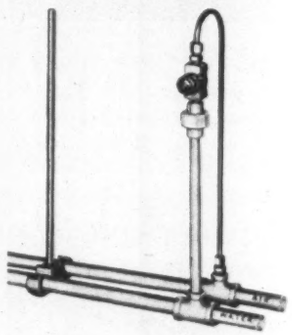
Whatever your drive needs, HOWELL can meet them EXACTLY and on time. Write us, outlining your particular problem!

OWELL ELECTRIC MOTORS COMPANY
HOWELL, MICHIGAN
Representatives in All Principal Cities

The thermometer-thermostat has a visible bi-metal thermometer and the timer-thermostat incorporates a compact 13 hr clock with an indicating dial showing the number of hours that will elapse before the thermostat will come into control.—General Controls Co., 801 Allen Ave., Glendale, Cal.

Humidifying Nozzle

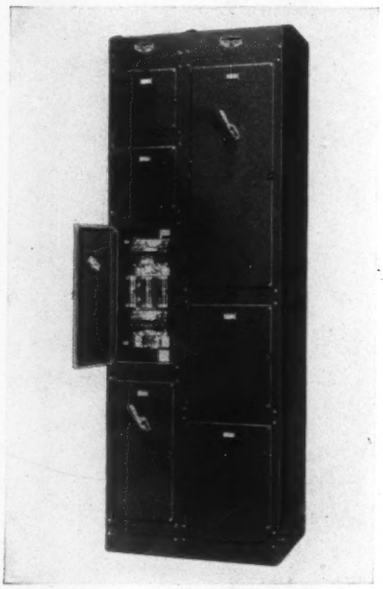
No. 1996—Illustrated here is a new humidifying nozzle which has just been placed on the market. A group of these nozzles may be mounted on the ceiling with water maintained slightly below the nozzle level by means of a float control tank.



Compressed air is controlled by a solenoid operated valve actuated by a humidistat. According to the manufacturer, the system is foolproof and cannot drip; if for any reason the air supply is shut off, water will drop back to the controlled level. — Spraying Systems Co., 4031 W. Lake St., Chicago, Ill.

Sectionalized Motor Control

No. 1997—"Unitrol" represents a new engineering idea in motor control installation, according to the manufacturer. Built on the same principle as sectional filing cabinets, it permits all needed types of control devices to be organized in locker-like motor control centers. Standardized construction allows quick building up of any control center to meet present requirements without special engineering, and future changes can be taken care of by adding or removing sections, or by replacing the unit controllers.

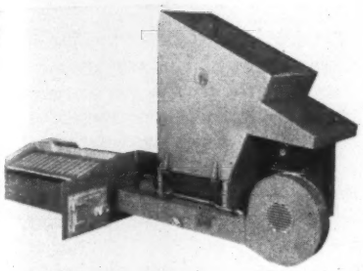


According to the manufacturer, this "pre-engineered flexibility" is of special value in the present period of industrial expansion for national defense.

The standardized cubic sections are made in 32 sizes—eight widths, four heights and one depth. Units are assembled with all wiring busses, supports, terminals and interconnections already made, or with provisions for wiring on the job. Blank steel panels are furnished for any unused sections and pushbuttons, meters and other accessories may be mounted on the blank panels.—Cutler-Hammer, Inc., N. 12th St. and W. St. Paul Ave., Milwaukee, Wis.

Commercial Anthracite Stoker

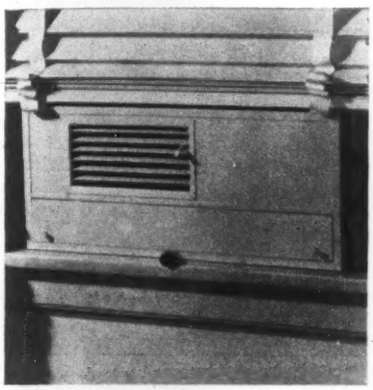
No. 1998—The new "Series 35" commercial anthracite stokers have been designed for high and low pressure steam boilers, hot water boilers and for industrial applications. They are available in nine sizes for loads ranging from 25 to 140 boiler hp. They utilize reciprocating ram blocks in the retort and also reciprocating grates, and have a metering type worm to deliver the coal from the hopper to the retort.



Two types have the retort in the center of the furnace with an ashpit on each side and two other types have the retort installed at one side of the furnace with a single ashpit. Air for combustion is supplied by a forced draft fan through air ports in the grate bars which are graduated so that the coal will be burned at a uniform rate.—Iron Fireman Mfg. Co., 3170 W. 106 St., Cleveland, Ohio.

Window Unit Restyled

No. 1999—Should a manufacturer make his product a thing of outstanding beauty, or should he seek to merge its identity into the general decor?, is the question a pioneer maker of ventilating units recently asked decorators and architects who, in turn, checked with their clients. According to this manufacturer, the idea has been to make such units more streamlined and more attractive to the eye, while the public has really wanted units that were not so obvious. This maker's line has, therefore, been restyled so that the unit will look like part of the window rather than to have it stand out. The aim has also been to keep the unit from projecting into the room.



These window ventilator filter units incorporate a centrifugal blower and an air filter, as well as a patented silencer to absorb street, motor and air noises. Capacity of the larger unit is 500 cfm, it is stated, and the smaller one handles 300 cfm.—Davies Air Filter Corp., 390 Fourth Ave., New York, N. Y.

Ball Tooth Universal Joint

No. 2000—The "Consolidated" ball tooth universal joint has been developed to increase the strength, durability and operating range, and to provide proper lubrication for the wearing surfaces, the manufacturer states. Designed for hand operation and not intended for continuous power drive, applications include the extended remote control of valves.

These universal joints have an operating range from zero to 90 deg.—Petroleum Engineering Co., 90 West St., New York, N. Y.

Steel Scaffold

No. 2001—A new safety steel scaffold for use by contractors, maintenance departments and others is designed to provide extreme interchangeability with a minimum number of separate units. No screws, bolts or clamps are used and no tools are required to erect or dis-assemble this scaffold.

It consists of square section tubular steel brace and corner post units of rigid construction with electrically welded parts. Design of the various units permits erection in a straight line, in corners, around rectangular or circular constructions, either "inside" or "outside." Bridging over obstructions is accomplished with truss units. Steel floor sections are supplied which may be placed at any point in the scaffold. This "Quick-Set" scaffold may be leased or purchased outright.—Mechanical Handling Systems, Inc., 4600 Nancy Ave., Detroit, Mich.

KNOW ALL MEN

in the

HEATING

AIR CONDITIONING

and

VENTILATING BUSINESS

that

Asbestos Protected DUX-SULATION

is the accepted and approved insulating material for covering ducts to preserve and maintain temperatures . . . for lining ducts to prevent noise and sound travel . . . to save fuel . . . to prevent condensation . . . to balance system operation . . . to reduce insulation costs . . . to simplify application . . . to improve appearance.

DUX-SULATION is protected in U. S. and Canadian Patent Offices.

•

Write office nearest you for details.

GRANT WILSON, INC.
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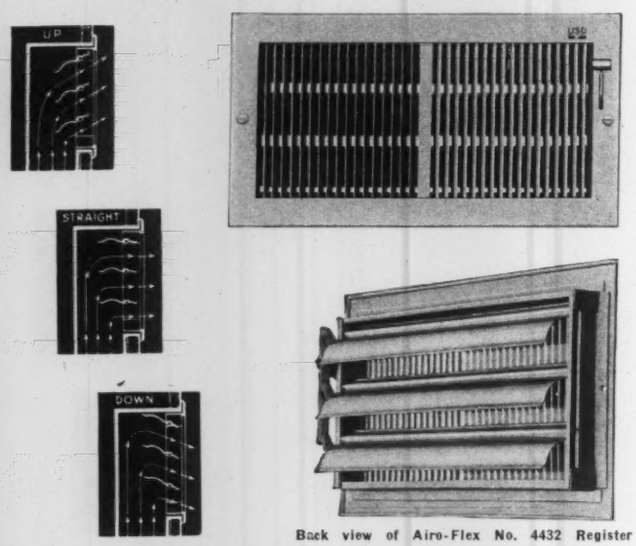
AIR CONDITIONING UTILITIES CO.
8 West 40th Street NEW YORK

ATLAS ASBESTOS CO., LTD.
110 McGill Street MONTREAL, CANADA

•Airo-Flex Gives Easy 4-Way Direction Control



Back view of Airo-Flex No. 4432 Register

FOR a modern air conditioning register which has every worth-while feature, you'll pick this outstanding Auer Airo-Flex "4000." Its multi-louvre back blade, operated by lever, directs air flow at any angle upward, level, or as much as 22½° downward. Indicator on face shows position of blades. For sideway air deflection, a simple adjustment of grille bars, at time of installation, with turning tool furnished, gives you any combination or single flow, straight, right or left. With the fine appearance of a *higher priced* register, and with every detail of construction and finish strictly up to Auer quality, the "4000" merits your use wherever a high-grade yet *economical* register is called for.

Send for complete Auer Register Book 40 illustrating all Auer Air Conditioning and Gravity Registers and Intakes. Separate Catalog "G" also available on Auer Grilles.

THE AUER REGISTER COMPANY
3608 Payne Avenue Cleveland, Ohio

AUER REGISTERS & GRILLES

For Air Conditioning *and* Gravity

Water Lubricated Pump Bearing

No. 2002—A new type of water lubricated bearing for use in deep well vertical pumps has been developed by heavy application of electrolytically deposited chromium over a monel stainless sleeve, swaged into a vertical pump shaft, the pump shaft being armored with heavy chromium over a non-corrosive metal sleeve every 10 ft. These sections of the shaft operate within resilient cutless rubber journals which are fluted and are non-revolvable. Any sand in the water flushes through the bearing, it is stated, and because of the hardness and thickness of the chromium, and its bearing contact with the rubber, no abrasion occurs.

By the new process, the chromium is electrolytically deposited to monel to a thickness of approximately 3/1000 of an inch, more than 50 times as thick as ordinary automotive chromium plating, according to the manufacturer.—Peerless Pump Div., Food Machinery Corp., 1250 Camden Ave., S. W., Canton, Ohio.

Portable Humidifier

No. 2003—A portable humidifier for office or home use is based on the "pre-evaporative" principle, according to the manufacturer, which feature moistens the air as it is drawn into the humidifier and eliminates mist or vapor. Dry, hot air is drawn through the moistened filter where it is cleaned and humidified and the moistened air is then blown through the room by a propeller fan, the air absorbing water according to its relative humidity.

The humidifier is styled in walnut of 18th century design. No water connections are needed, and the power required to operate the fan is about equal to that used by a 50 watt lamp. The unit will add to the air from 2 to 5 lb per hr of water, it is stated.—Carrier Corp., 302 S. Geddes St., Syracuse, N. Y.

Vertical Shaft Unit Heaters

No. 2004—The new vertical shaft, propeller fan "hiJet" unit heaters are offered to provide a vertical downward discharge of heated air, and are of the blow through type.

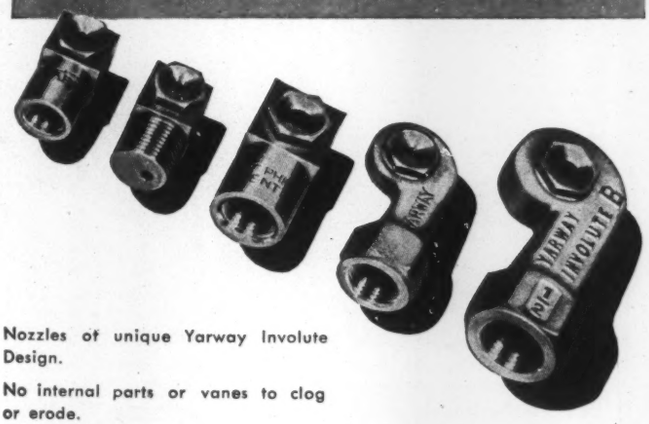
There is one model for high ceiling location which provides high outlet velocity and is available in three different outlet arrangements, one to project a single column of air straight down, one projecting two columns of air at angles of 30 deg to vertical, and a third arrangement projecting the air at 30 deg to vertical in all directions. A second model is designed for low outlet velocities for applications where it is not necessary to suspend the heaters at great distances from the floor; there are two discharge arrangements for this model, one having a specially designed outlet for diffusion of heated air.

The heating element features expansion bends and a patented stay tube. The fan is designed with a wide face area and aerodynamic or streamline shape for efficient and quiet operation, the maker states.

The model for mounting heights from 12 to 18 ft is available in six sizes providing from 43,000 to 193,000 Btu. The model for mounting heights from 18 to 45 ft may be had in capacities ranging from 98,000 to 500,000 Btu.—Herman Nelson Corp., 2nd St., Moline, Ill.

For your convenience in obtaining more information about any of this equipment, see coupon on page 106. Add the new products and companies listed here to your Directory Section which you received in your January, 1940, HEATING, PIPING AND AIR CONDITIONING and thus keep your records of sources of supply up to date throughout the year . . . Single asterisk (*) indicates equipment not listed in Directory Section; double asterisk (**) equipment and manufacturer not listed

AIR CONDITIONING NOZZLES



Nozzles of unique Yarway Involute Design.

No internal parts or vanes to clog or erode.

Insure trouble-free air washing service.

Sizes and types for all requirements.

Many large users—installations total more than 5 million gallons per minute in water cooling and air conditioning service. Write for Bulletin N-615.

YARNALL-WARING COMPANY
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YARWAY

VALVES Serve the "Nation's Most Exclusive Residential Section . . ."
("Life"—October, 1939)

Where people of "Discrimination" gather for relaxation and refreshment, refrigeration must be DEPENDABLE! And so it is —at the large and beautiful PUNCH and JUDY Bar, in the exclusive Village of Grosse Point Farms. Michigan.

In the new cooling system recently installed here by the A. Claus Company of Cleveland, seven A-P No. 207 Thermostatic Expansion Valves are performing with their customary Dependability . . . *Offering the last word in Refrigerant Control accuracy that makes the installation completely satisfactory to the Owner—and profitable for the Service Engineer.*

Model 207
Thermostatic Expansion Valve

Used in the PUNCH and JUDY Bar, and in thousands of Cooling Systems throughout the country. Offers the advantages of small body size, large capacity, close accurate control, supersensitivity, easy superheat adjustment, and many other typical A-P features that make it a valuable unit on any installation.

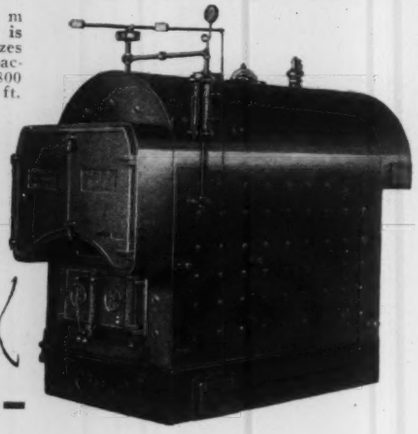
A-P Valves add DEPENDABILITY to Refrigeration and Air Conditioning everywhere. To thousands of Engineers, this DEPENDABILITY in refrigerant control is so important that the thought of a substitute is impossible.

A-P DEPENDABILITY is worth money — to YOU, too! Cuts your service expense on new installations as well as on replacements — helps you build a longer list of satisfied customers — to increase your business. *If you haven't already proved this in YOUR experience, start using A-P Valves NOW!*

★ Progressive Service Engineers Use and Recommend—and Aggressive Jobbers Stock and Talk—A-P Products.

AUTOMATIC PRODUCTS COMPANY
2460 NORTH THIRTY-SECOND STREET
MILWAUKEE WISCONSIN

Burnham Welded Steel is made in 19 sizes ranging in capacities from 1,800 to 42,500 sq. ft.



Hank SEZ—

What's In Front of a Boiler Is What's In Back of It

HERE lately I went inter a drug store with a friend what needed a tube of some shaving suds.

There wuz a smart squirt behind the counter what tried to sell him one of them wild cat brands costing a lot less.

But my friend insisted on Colgate's.

When we got outside I said, "What the heck, Bill, why not save the money."

Bill replied, "I don't know no one in Colgate's personally, or what's in their shaving suds, but I know the reputation Colgate has, and that's enuff fur me to go by."

"Same with steel boilers," sez he.

"They're all built to a specification. But in addition, Burnham's is backed by a reputation.

"One built up in 73 years of making whatever they made, jist the best they knowed how. Which is good enuff fur most folks."

Hank Hindle

BURNHAM BOILER CORPORATION

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Irvington, N.Y., *Dept. P* Zanesville, Ohio, *Dept. P*

Branch offices in all Principal Cities

Export Dept.: 50 Church St., New York City

Burnham Boiler

Steam Pressure for Central Heating

Reader's Question Answered

by Samuel R. Lewis*

A reader of HPAC has asked for some information on the economical pressure range for a heating plant for a group of buildings. "I am aware," he says, "that it is common practice in such plants to operate the boilers at 10 to 25 lb per sq in., and am wondering about the advisability of increasing the pressure to 150 to 200 lb, further pressure reductions to be made at the buildings. I am particularly interested in relative size of a 250 hp boiler, line losses, and comparative economy data."

The author has had under consideration from time to time a number of heating system change-overs from high to low pressure operation, but has never been called upon to change over from low to high pressure operation, there being no reason for such a change-over except in metropolitan areas where high pressure distribution mains increase the load carrying capacity and reduce the space needed for underground piping, or where there is need for high temperature and pressure at some remote building.

There are many small electric generating plants in industrial buildings the machinery of which has become obsolete, where it is proposed to purchase electric energy from a public service company rather than to mod-

*Consulting Mechanical Engineer. Member of HPAC's Board of Consulting and Contributing Editors.

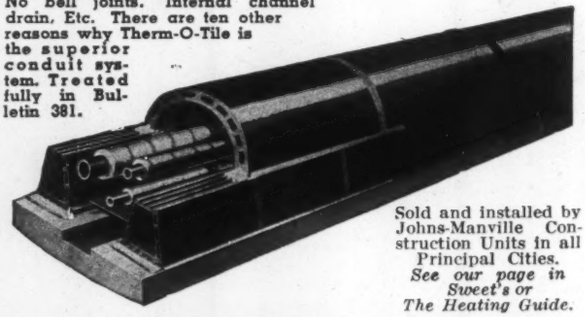
The Conduit for Underground Pipe Lines

THERM-O-TILE

Reg. U. S. Pat. Off.

SIMPLEST • STRONGEST • MOST EFFICIENT

Monolithic concrete base. No broken stone fill. Strong arched construction. No bell joints. Internal channel drain, Etc. There are ten other reasons why Therm-O-Tile is the superior conduit system. Treated fully in Bulletin 381.



Sold and installed by Johns-Manville Construction Units in all Principal Cities.
See our page in Sweet's or The Heating Guide.

H. W. PORTER & CO., Inc.

822-H Frelinghuysen Ave., Newark, N. J.

Without obligating us in any way, ☐ Please send Bulletin 381. ☐ Send representative. ☐ Enclosed is a sketch, with principal data of a prospective job on which we shall be glad to have your comments or quotations.

Name .....

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City..... State.....

ernize the old plant. These buildings, however, must continue to be heated, and almost invariably the steam pressure is reduced when the old engines are scrapped.

No involved mathematics are required to demonstrate that with lower steam temperatures there will be reduced heat loss into the air and into the ground from the steam distributing piping and that there will be reduced maintenance expense for valves, packing, expansion joints, etc. Steam at 150 lb gage has a temperature of about 366 F; if sent through a reducing valve so that its pressure is stepped down to 50 lb for transmission underground the normal temperature would be about 298 F. The reduced pressure steam then would carry 366 F — 298 F = 68 F superheat. This superheat would have to be lost somewhere before condensation or utilization of the latent heat in the steam could commence.

On arrival of the steam at a building some distance from the boiler house it is probable that the original superheat all will have been transmitted into the ground and that considerable condensation will have accumulated in the main. This condensation at 50 lb pressure must be trapped out of the steam supply, since water mixed with steam is not conducive to efficient or quiet pressure reducing valve operation. The water trapped out at 50 lb pressure of course re-evaporates to a considerable extent when the pressure is reduced.

At the building the 50 lb condensation and the steam leaving the reducing valve are at approximately 298 F, and when reduced to, say, 2 lb gage for distribution will have a superheat of 298 F — 218 F = 80 F. This superheat partly can be utilized for re-evaporating the main line condensation provided that the main line drain-

Discharge-at high pressure up to 223,000 lbs./hr.

COCHRANE DISCHARGERS

For large capacity drainage at differential pressures up to 2,000 lbs. Operates equally well against high back pressures or vacuum . . . no water seal or prime is required . . . pilot valve control assures positive operation and prevents steam leakage . . . drainage increases with increasing pressures. Further details of design, operation, capacities, and applications are interestingly described in Publication 2935. Write for it today.

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COCHRANE

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20" x 30" Suitable for Mounting, Covering 35 Thermostatic Filling Liquids . . . . .

We have just published our engineering department chart, recording the relation between vapor pressure and temperature of a large number of thermostatic filling liquids.

The compilation of this chart required practically an entire year of intensive work on the part of our laboratories, and the information will, we believe, be invaluable to laboratories or engineering organizations requiring such data.

A limited quantity of these charts is available for those seriously interested. Address your request to

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HYDRON METALLIC BELLOWS

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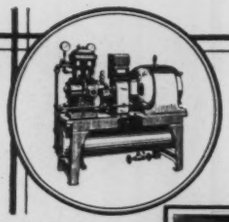
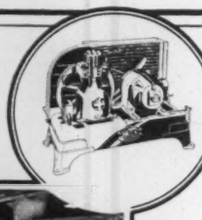
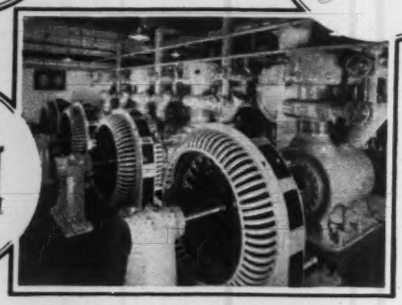


Low Pressure Units 1/4 to 15 Hp.



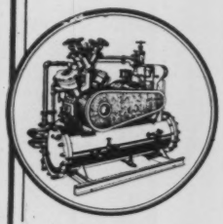
Direct-Drive Ammonia Units, 1/2 Hp.



Freon-12 Units, 10 to 30 Hp.

4 Large 2-Cyl. Frick Compressors in Air Conditioning Service at the Philcade and Philtower Buildings, Tulsa, Oklahoma.

You're always right with FRICK Refrigeration

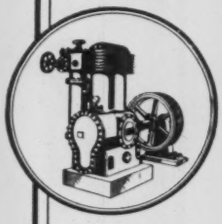


Type AV Ammonia Units 25 to 30 Hp.

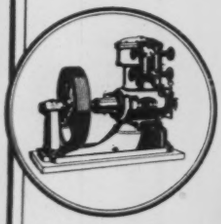
Because there's always a Frick machine of the type and size to suit your needs exactly. And 85 years' experience is built into every one of them—your assurance of dependable, profit-making operation.

Whether your problem is air cooling, dehumidification, or complete air conditioning through a central system or by individual units, you can get helpful recommendations from your nearest Frick Air Conditioning Sales Engineer.

Frick Branch Offices and Distributors in principal cities: write, wire or phone today.



Freon-12 Compressors in 6 Sizes

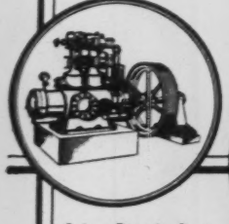


Ammonia Compressors in 10 Sizes

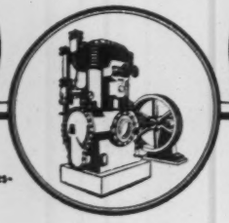
DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

WAYNESBORO, PENNA. U.S.A.



Booster Compressors in 6 Sizes



Carbon Dioxide Compressors in 6 Sizes

Large 4-Cyl. Compressors in 5 Sizes

age trap in the building discharges into a flash tank which is connected into the heating system on the low pressure steam side of the reducing valve.

The Boiler

A 250 hp boiler ordinarily is no larger or smaller whether it delivers the steam at 150 or at 15 lb pressure. It will cost more, however, to secure the same heat transmission efficiency at the higher pressure, since with less difference in temperature between the water and the combustion gases (the case at higher pressure) more heat absorbing surface must be installed inside the boiler. It will cost more also for fuel with high pressure operation, because of this same reduced difference in temperature. Some of this extra cost for fuel may be made up by better combustion conditions in the higher temperature furnace, but the two situations are not self-compensating.

A long underground pipe line for 50 lb steam of course can be much smaller than one to do the same work with 15 lb steam. The ideal piping design is one which makes the diameter so small that the friction losses will absorb the superheat and the super-pressure, delivering steam at the building in a saturated condition without any free water and at the desired pressure. However, if the pipe line is just right for such an effect under the heaviest load the line will not absorb the superheat and pressure under the much reduced warm weather load.

Because of variations in the resistance to steam flow

DIRTY FILTERS can ruin the efficiency of the best air-conditioning system made....

THIS Hays Air Filter Gage gives a constant check on Air Filter conditions. It prevents changing filters sooner than necessary and warns when they are clogged with dirt.

The Hays Air Filter Gage is permanently and easily installed — nothing to get out of order. Will last as long as the duct work. Write 990 Eighth Avenue, Michigan City, Ind., for special Bulletin No. 40-278.

THE HAYS CORPORATION

COMBUSTION INSTRUMENTS AND CONTROL

MICHIGAN CITY, INDIANA, U.S.A.

in the different building heating systems, difference in distance from the boilers and constant changes in the weather, a reducing valve and a trap and a flash tank are desirable anyway in every building served from a central plant.

Allow for Growth

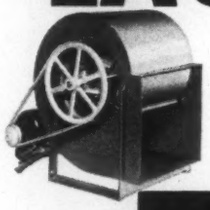
Few central plant heating systems are completed at the time of the original design, but keep on growing. For this reason an original design on the basis of a moderate boiler pressure, with primary operation at, say, 15 lb maximum but permissible future increase to, say, 50 lb is advisable.

I would not step down the pressure through reducing valves in the boiler room, unless it should be necessary to conserve the exhaust steam from pumps or the like, but would vary the boiler pressure and the line pressure reasonably in proportion to the weather so that the reducing valve and flash tank in the most remote building would just about be satisfied in weather during which the demand is greatest. For less remote buildings the pressure reducing valves will operate at all times to control the pressure according to the demands of each particular system.

Central Plant Heating with Hot Water

There are many interesting possibilities in connection with moderate sized central plant heating systems. One is the use of circulated hot water in each building, the

LAU



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A Proven Way to Cut Costs in Solving Your Air Handling Problems

Ventilation—cooling—heating . . . what are your air handling needs?

For years, LAU has been solving all kinds of air handling and conditioning problems. Our experienced engineers offer you practical help in planning your installation, assuring satisfaction and every possible economy.

Lau offers over 20 sizes of light duty blower assemblies with arrangements for upward, downward, horizontal, and angle discharges . . . shipped ready to install. Ask for our catalog and complete details.

Write

THE LAU BLOWER CO.
2015 Home Ave. Dayton, Ohio

TAKE A NOTE TO THE BOSS—OUR RECORDS SHOW FAIRBANKS VALVES GIVE THE BEST SERVICE AND COST LESS FOR MAINTENANCE, SO . . .
CHIEF ENGINEER

You, too, will agree that Fairbanks are *quality* valves if you give them a trial.

Their extensive use is conclusive proof of their satisfactory performance, long life and low maintenance cost . . . evidence that they assure easy and quick operation, positive shut-off and easy renewal. They give the greatest resistance to wire-drawing, corrosion and erosion.

Castings are carefully tested to make sure that there are no imperfections. All parts are gaged to insure a perfect fit. And after assembly every valve is subjected to the most severe test.

Made in standard and renewable types, for pressures from 125 lbs. to 350 lbs., there is a Fairbanks Valve to meet almost every specific requirement.

We'll send you a Fairbanks Valve on trial. If you are not satisfied return it in 30 days and we'll make no charge.

Write today stating size and type desired and also ask for catalog No. 21.

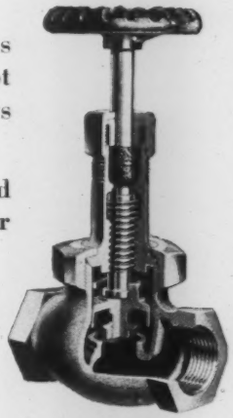
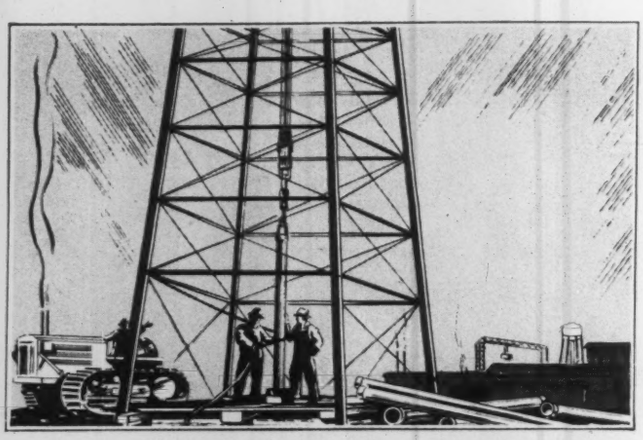


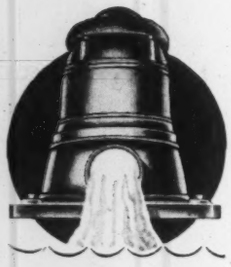
Fig. U-01
150 lb. pressure

The Fairbanks Company
Valves, Dart Unions, Hand Trucks and Wheelbarrows
396 Lafayette St., New York, N. Y.
Boston, Pittsburgh—Distributors in Principal Cities
Factories: Binghamton, N. Y., Rome, Ga.

Fairbanks *Standard and* Renewable **Valves**



DON'T LET WATER SHORTAGE "BOTTLE NECK" YOUR PRODUCTION



If you are in need of more water for increasing production, consider the immediate installation of new Wells and Pumps. Such a move may prove necessary at an early date and very likely it will be one of splendid economy. Municipal water plants may not be able to continue favorable rates, nor may they be able to care for greatly increased water supplies to factories.

Of course, you will consider Layne Wells and Pumps above all others, for they are proven in efficiency, long life, low operation cost and dependability. In addition, Layne offers a nation wide organization adequate in size and equipment to always provide service when and as needed. Excellent manufacturing facilities keep step with pump and well supply needs.

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LAYNE-ARKANSAS CO. STUTTGART, ARK.
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INTERNATIONAL WATER SUPPLY, LTD., LONDON . . . . . ONTARIO, CANADA

Layne engineers are ready to cooperate on your water supply problems. They will recommend the types of Wells and Pumps best suited for your needs. There is no obligation in enlisting their aid. Late catalogs, folders and bulletins may be obtained by addressing,

LAYNE & BOWLER, INC.
Dept. D, Memphis, Tenn.

LAYNE

PUMPS & WELL WATER SYSTEMS

For Municipalities, Industries, Railroads, Mines and Irrigation

water heated in each building by steam from the central plant at any pressure convenient. The water temperature for each building can be controlled in accordance with weather conditions. This does away with the maintenance of separate pressure reducing valves in each building and gives a wide range of water temperature variation for heat control.

Another scheme is to pump hot water from the central plant, throttling the circulation to each building with a differential valve which permits only enough water to circulate through each individual system to maintain design conditions and which by preventing excess circulation insures maintenance of the design pressure differential throughout. With this scheme any exhaust steam that may be available in the boiler house can be condensed in a closed feed water heater and saved without appreciable back pressure.

Two Supply Mains

Many European institutions have two forced circulation hot water supply mains, one of larger diameter than the other, and one return main. In comparatively mild weather the smaller supply main is used. In colder weather the larger supply main is used, and in the most severe cold weather both supply mains are in service. Since the water is under mechanical circulation there is no prejudice against the single underground return main common to both supply mains, and considerable economy in heat transmission and flexibility in the distribution is said to be accomplished.

★ GENERAL CONTROLS ★
SOLENOID VALVES
SUITABLE FOR EVERY GAS, LIQUID AND VAPOR

COME TO HEADQUARTERS FOR ALL YOUR NEEDS FOR SOLENOID VALVES

Pioneers and leaders in the manufacture of quiet A.C., trouble-free, 2-wire controls, for all services. Write today for complete Catalog. Nationwide sales and service.

GENERAL CONTROLS
267 Fifth Avenue, New York City
350 East Ohio Street, Chicago, Ill.

Booklets, Reports and Papers

Leather Belting Standard

The urgency of the times is resulting in thousands of manufacturing plants throughout the country reconditioning old machinery and installing new equipment. Since much of this machinery is driven by means of leather belting, it is appropriate to note that the draft of a proposed American Standard for Specifications and Horsepower Ratings of Vegetable-Tanned Flat Leather Belting has recently been completed by a sectional committee. This committee was organized under the procedure of the American Standards Association with the American Society of Mechanical Engineers as sponsor and the engineering committee of the American Leather Belting Association as collaborator.

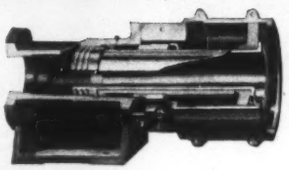
Drafts of the proposed standard are now being distributed to all industries concerned with leather belting for criticism and comment. Any engineer or company interested in this problem who has not received a copy may obtain one by writing to George B. Haven, chairman of the sectional committee on standardization of leather belting, American Society of Mechanical Engineers, 29 W. 39th St., New York, N. Y.

Oxy-Acetylene Welding and Cutting

A course of classroom exercises and lectures covering the oxy-acetylene welding and cutting processes has been prepared by Air Reduction Sales Co., 60 E. 42nd St., New York, N. Y. The course consists of two separate books, one containing a complete set of work sheets and the other lecture material to be used as a supplement to the first.

The book covering classroom exercises is intended to impress the fundamentals upon those who are interested in gaining a

ADSCO PISTON RING JOINT



It can be
UNPACKED *and* **REPACKED**
Under Full Operating Pressure

No interruption to service. Piston Rings in the internal guide hold the line pressure during the unpacking and repacking operation.

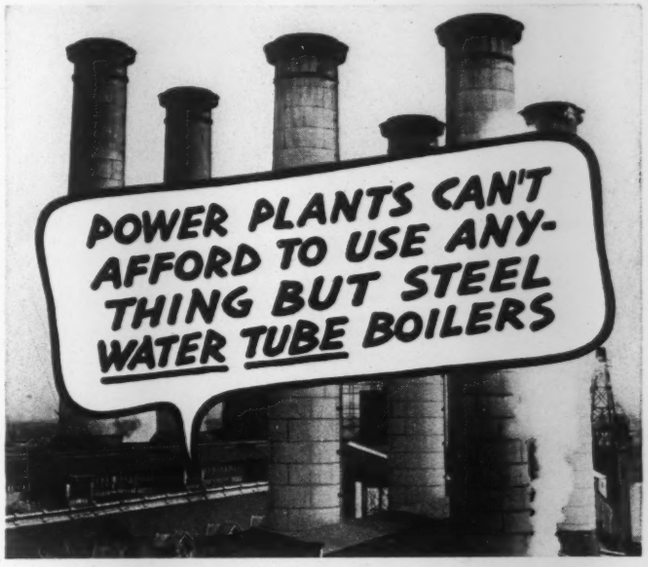
Fully guided by an internal guide ring and by an external guide in the two-piece hood. Available in single or double joints for high pressures and high temperatures with flanged or beveled ends.

Write for Bulletin No. 35-15HP

A FEW USERS

Los Angeles Union Passenger Terminal Los Angeles, Calif.
Northwestern University, Evanston, Ill.
Goodyear Tire & Rubber Co., Akron, Ohio.
Standard Oil Company of California
Johnson Wax Company, Racine, Wis.
Arapaho Indian Agency, Concho, Okla.
City of Kingston, Kingston, N. C.
Delco Appliance Corp., Rochester, N. Y.
American Enka Corp., Enka, N. C.
St. Francis Orphanage, Providence, R. I.
Fisk University, Nashville, Tenn.

AMERICAN DISTRICT STEAM COMPANY
NORTH TONAWANDA, N.Y.
IN BUSINESS OVER SIXTY YEARS

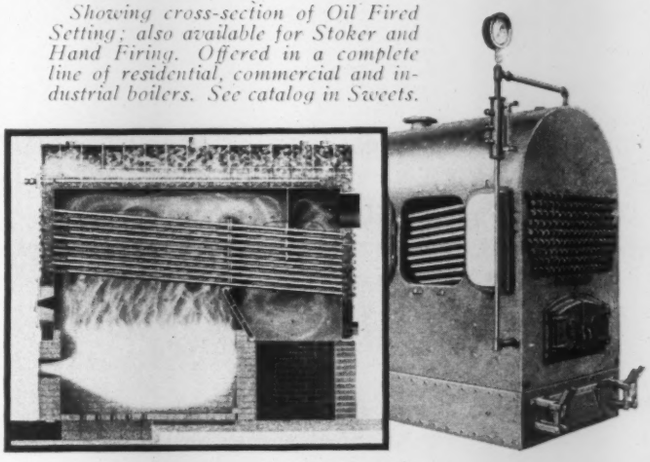


International "FUEL-SAVER" WATER TUBE BOILERS are designed to give modern heating systems and industrial power plants the very same pinch-penny efficiency and flexible performance *demanded* by all large steam generating stations.

Today, the conservation of fuel is becoming more and more important. International Water Tube Boilers have earned the name of "FUEL-SAVER" because they are designed for complete absorption of hot gases, rapid and positive internal water circulation, and quick steaming. The result is great flexibility and low stack temperature under *all* load conditions.

Now is the time to become fully familiar with the superior advantages that steel water tube boilers have brought to the heating, industrial power and processing fields.

Showing cross-section of Oil Fired Setting; also available for Stoker and Hand Firing. Offered in a complete line of residential, commercial and industrial boilers. See catalog in Sweets.



Write for convincing proofs and details.

THE INTERNATIONAL BOILER WORKS CO.
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Established 1886

"FUEL-SAVER"
WATER TUBE
STEEL HEATING & POWER BOILERS

working knowledge of the art. Its 22 chapters desc... tice of both oxy-acetylene welding and cutting.

The course of lectures, although printed in a ... works in close conjunction with the student ... describes the history of the art, the properties of ... its theories and its practical applications in indust...

The course of classroom exercises sells for 50c ... lecture books are $1.00 each.

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Patterson Copper-Lined Hot Water Heater in Y. M. C. A. building, Dayton, Ohio.

Rust—the most insidious of all hot-water diseases—can never eat holes in a hot water heater, clog pipes nor cause red water if you install a Patterson Everdur or Copper-Lined Hot Water Heater. These heaters can't possibly rust because water does not touch anything but copper in

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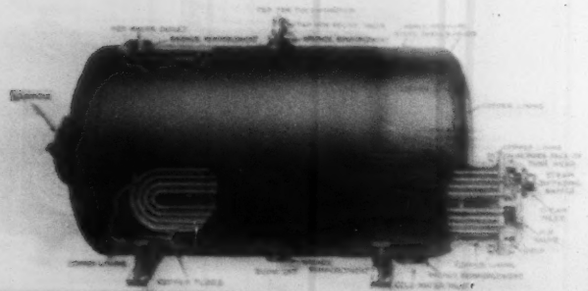
Here's another thing you'll appreciate. Dirt and precipitation cannot cling to copper but drops to the bottom of these heaters. Consequently to clean Patterson Heaters, it is only necessary to draw off the COLD water at the bottom instead of emptying ALL THE HOT WATER.

Moreover, Patterson Heaters are guaranteed to furnish all the hot water required, as hot as required and as quickly as required.

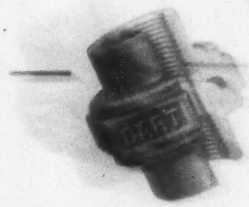
Patterson Heaters give the greatest return per dollar invested. Write for our large catalog.



THE PATTERSON-KELLEY CO. INC.

COMPARE A DART

with any other union . . .



Check Dart features, point by point, and just see if you can match them in any other union. Notice the spherical shape of Dart's two bronze seats. . . Notice that they're precision ground. This exclusive "true-ball" joint means quick, sure tightness in installation — longer, leak-proof service. Notice, too, the sturdiness of the body and cap. They're made from air refined malleable iron — a metal proved to have low stretch and high resistance to hammer knocks. . . Dollar for dollar you'll get maximum service in Darts.

DART UNIONS

THE DART MFG. CO. PROVIDENCE, R.I.

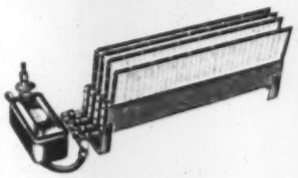
Conventions and Expositions

Air Hygiene Foundation: Annual meeting, November 12-13, Mellon Institute, Pittsburgh, Pa. Headquarters office, 4400 Fifth Ave., Pittsburgh, Pa. Prof. Philip Drinker is to head a symposium highlighting health safeguards in the mining, mechanical and chemical industries which bear the brunt of preparedness production, and William P. Yant will talk on protection of civilians in war time, especially from dangerous gases.

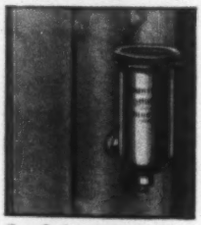
American Society of Mechanical Engineers: Annual meeting, December 2-6, Hotel Astor, New York, N. Y. Headquarters office, 29 W. 39th St., New York, N. Y. Tentative program includes papers on coal ash in boiler furnaces, a session on boiler feedwater studies, papers on thermometric time lag, reset controllers, flow processes in underfeed stokers, automatic control of surge tanks, pressure loss formulas for centrifugal dust collection, experience in the application of wet type dust scrubbers, water purification and treatment in the textile industry, a mechanical method for solving pipe problems involving temperature expansion, condenser tubes and their corrosion, flow of saturated steam through orifices, drying in the textile industry, discharge coefficients of long radius flow nozzles when used with pipe wall pressure taps, calibration of volumeters, heat transfer to gases inside tubes, high temperature bolting material, effect of structure on high temperature properties of carbon-molybdenum steel, and a report on tubular creep tests.

Power Show: 14th National Exposition of Power and Mechanical Engineering, December 2-7, Grand Central Palace, New York, N. Y. Under management of International Exposition Co., Grand Central Palace, New York, N. Y.

CONVECTOR
AUTOMATIC HUMIDIFIERS



Designed especially for Hot Water, Steam, or Vapor, Concealed Convector Radiators. For concealed radiators there is no better humidifier than the Maid-O'-Mist Convector Automatic Humidifier. Designed especially for this purpose it is naturally most efficient in operation. The automatic water feeder controls water level in the troughs . . . the patented metal edge evaporators last indefinitely and assure maximum evaporation . . . corrosion is avoided by the use of non-ferrous metals throughout . . . and its operation is safeguarded from pipe scale, dirt, etc., by a Monel metal filter screen. The Maid-O'-Mist Convector Automatic Humidifier comes completely assembled for installation in two and four troughs, sizes ranging from 22" to 39" in length over all.



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Send for catalogue on complete line of humidifiers for all types of heating systems at once.

MAID-O'-MIST INC.
211 NORTH ABERDEEN STREET
CHICAGO ILLINOIS

AUTOMATIC HUMIDIFIERS
FOR ALL TYPES OF HEATING SYSTEMS

Waterloo
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TOPS
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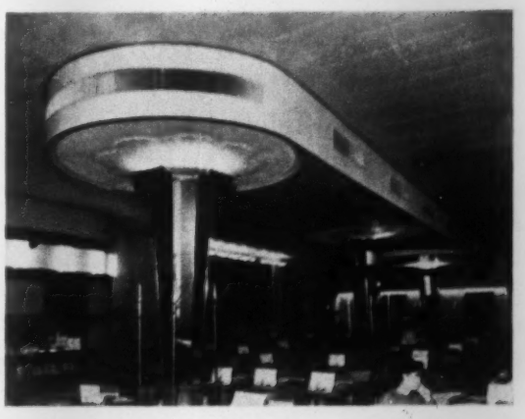

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Waterloo, Iowa **Seattle, Wash.**

Representatives in all principal cities.

Waterloo
AIR DIFFUSION EQUIPMENT

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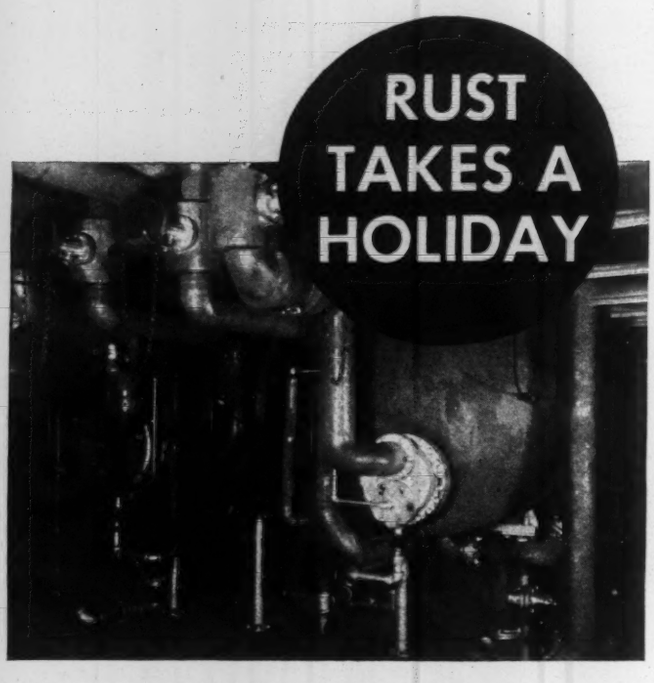

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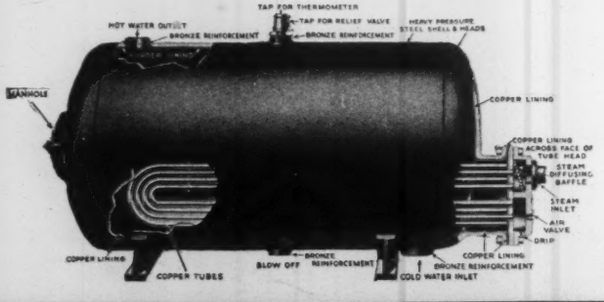

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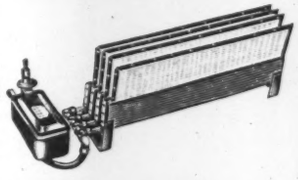

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211 NORTH ABERDEEN STREET
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Waterloo
AIR DIFFUSION EQUIPMENT

TOPS
in APPEARANCE
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in EFFICIENCY

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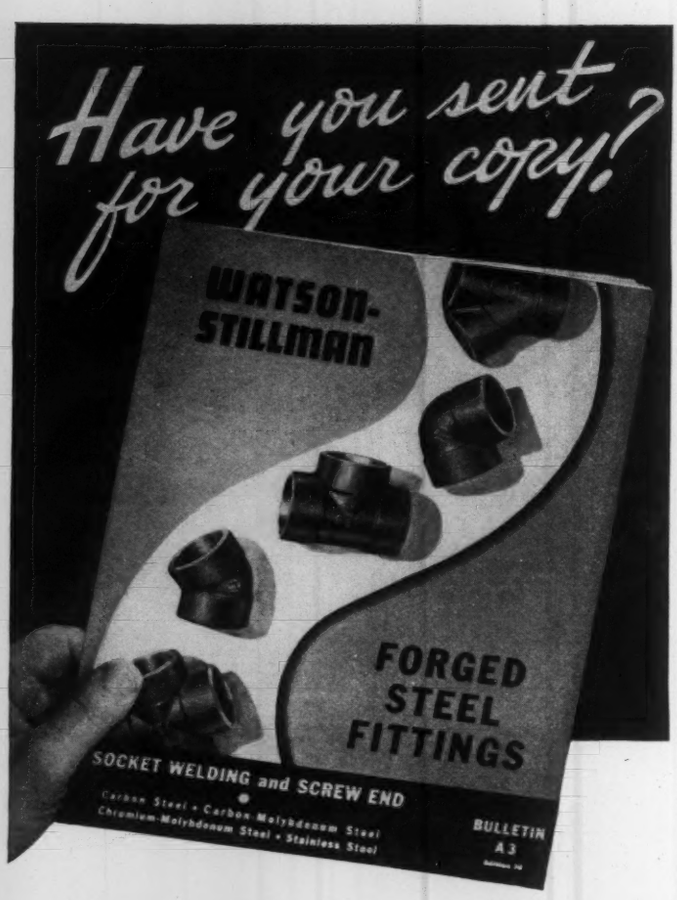
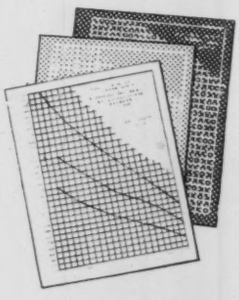


Specifications, dimensions and prices on the complete line of W-S Forged Steel Fittings are listed in this new bulletin ● W-S Screwed Fittings of forged carbon and alloy steels in three pressure classes—2000, 3000 and 6000 pounds ● W-S Socket Welding Fittings of forged carbon and carbon-molybdenum steels for use with Schedule 40, 80, 160 and double extra heavy pipe ● Several pages of usable engineering data have been included. Information that you will find helpful in solving your piping problems. Write for your copy now!

THE WATSON-STILLMAN CO., ROSELLE, NEW JERSEY



PRESSURE TEMPERATURE *Charts*

Use the pressure-temperature charts on Pages 21 to 25 of Bulletin A-3. You will find them most helpful in selecting the right class of fitting for your particular requirements.

WATSON-STILLMAN
Forged Steel Fittings

American Chemical Exposition: December 11-15, Stevens Hotel, Chicago, Ill. Under auspices of Chicago section, American Chemical Society. Exposition manager, Marcus W. Hinson, 110 N. Franklin St., Chicago, Ill.

Refrigeration and Air Conditioning Exhibition: January 13-16, Stevens Hotel, Chicago, Ill. Sponsored by Refrigeration Equipment Manufacturers Association, R. M. McClure, executive secretary, 111 W. Washington St., Chicago, Ill.

American Society of Heating and Ventilating Engineers: Annual meeting, January 27-29, Hotel Muehlebach, Kansas City, Mo. A. V. Hutchinson, secretary, 51 Madison Ave., New York, N. Y.

National Oil Burner Progress Exhibition: March 17-22, Commercial Museum, Philadelphia, Pa. Official hotel headquarters, Hotel Benjamin Franklin. Sponsored by Oil Burner Institute, 30 Rockefeller Plaza, New York, N. Y.

American Society of Heating and Ventilating Engineers: Semi-annual meeting, week of June 16, San Francisco, Calif. A. V. Hutchinson, secretary, 51 Madison Ave., New York, N. Y.

Pacific Heating and Air Conditioning Exposition: June 16-20, Exposition Auditorium, San Francisco, Calif. Under auspices of American Society of Heating and Ventilating Engineers, and under management of Charles F. Roth, International Exposition Co., Grand Central Palace, New York, N. Y. Walter L. Fleisher is chairman of the advisory committee.

American Society for Testing Materials: Annual meeting, and exhibit of testing apparatus, June 23-27, Palmer House, Chicago, Ill. Headquarters office, 260 S. Broad St., Philadelphia, Pa.

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FINNED COILS

FOR HEATING AND COOLING

AVAILABLE IN A WIDE RANGE OF SIZES

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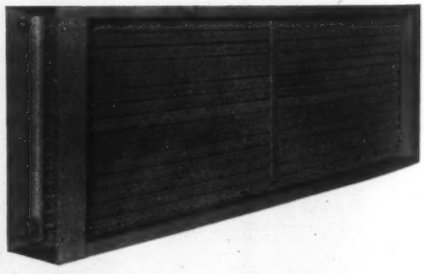

WATER COOLING COILS

THE G&O MANUFACTURING COMPANY
New Haven, Connecticut
Pioneer Manufacturers of Square Finned Tubing in the United States

Recent Trade Literature

For your convenience in obtaining copies of these bulletins, see coupon on page 106. If you write direct to the manufacturer, describe carefully what literature you want, as the number given first in each item is for use only when sending your request to HEATING, PIPING AND AIR CONDITIONING.

No. 3684. AIR CONDITIONING COILS: Kramer Trenton Co., 626 Brunswick Ave., Trenton, N. J. 32 p. catalog (AC540) on "Turbo-Fin" surface, with data on selection of direct expansion coils, steam coils and water coils, rating tables, conversion factors, roughing-in dimensions, other information and instructions on ordering.

No. 3685. AIR CONDITIONING FOR NATIONAL DEFENSE: Carrier Corp., 302 S. Geddes St., Syracuse, N. Y. 20 p. booklet, entitled Production for the Emergency and After, outlining the part air conditioning is playing in speeding up national defense production. Twenty-six industrial "case histories" where absolute control of air is essential to production are cited.

No. 3686. AIR WASHERS: Buffalo Forge Co., 171 Mortimer St., Buffalo, N. Y. 28 p. bulletin (3142-A) on line of air washers which has been manufactured continuously for more than 40 years. Much new material is included in the bulletin and it has information on special equipment. Types of air washers, details of construction and tabulated data are included.

No. 3687. ALLOYS: International Nickel Co., Inc., 67 Wall St., New York, N. Y. 32 p. technical information bulletin (T-2) on welding, brazing and soft soldering of "Monel," nickel and "Inconel."

No. 3688. BEARINGS: Stephens-Adamson Mfg. Co., Aurora, Ill. Data sheet on new "Style A" extended inner ring

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Statement of Ownership and Management of Heating, Piping and Air Conditioning for October 1, 1940

The following is a statement of ownership, management, etc., as required by the Acts of Congress of August 24, 1912, and March 3, 1933, of HEATING, PIPING AND AIR CONDITIONING, published monthly at Chicago, Ill., for October 1, 1940:

State of Illinois, County of Cook, ss: Before me, a Notary Public in and for the State and county aforesaid, personally appeared F. P. Keeney, who, having been duly sworn according to law, deposes and says that he is the business manager of HEATING, PIPING AND AIR CONDITIONING, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business manager are:
Publisher, Keeney Publishing Company, Chicago, Illinois.
Editor, Chas. E. Price, Chicago, Illinois.
Managing Editor: C. M. Burnam, Jr., Chicago, Illinois.
Business Manager, F. P. Keeney, Chicago, Illinois.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)
Keeney Publishing Company, 6 North Michigan Ave., Chicago, Illinois. Stockholders: F. P. Keeney, Chicago, Illinois; W. J. Osborn, Fairfield, Conn.; R. Payne Wettstein, Chicago, Illinois; Chas. E. Price, Chicago, Illinois; Robert A. Jack, Cleveland Heights, Ohio.

3. That the known bondholders, mortgagees and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

F. P. Keeney,
Business Manager.

Sworn to and subscribed before me this 25th day of September, 1940.
Grace E. Waymire.
(SEAL) [My commission expires Feb. 10, 1942.]

KATHABAR

GIVES YOU DEFINITE, INDEPENDENT CONTROL IN

AIR CONDITIONING

● Kathabar solves difficult control problems in air conditioning by a new and radically different operating principle rather than by devices Humidity and temperature are under simple, separate, independent controls.

Get the facts about Kathabar and see for yourself how easily, accurately and economically you can control humidity and temperature regardless of outside factors.

No matter how you create desired temperature, Kathabar humidity control units can easily be admitted into the specifications. Let us tell you more about it.

SURFACE COMBUSTION CORPORATION, Toledo, Ohio

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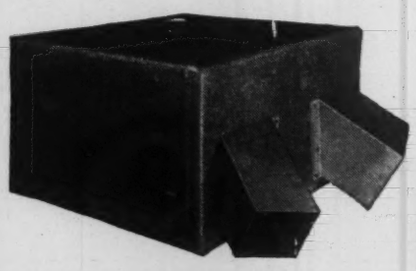

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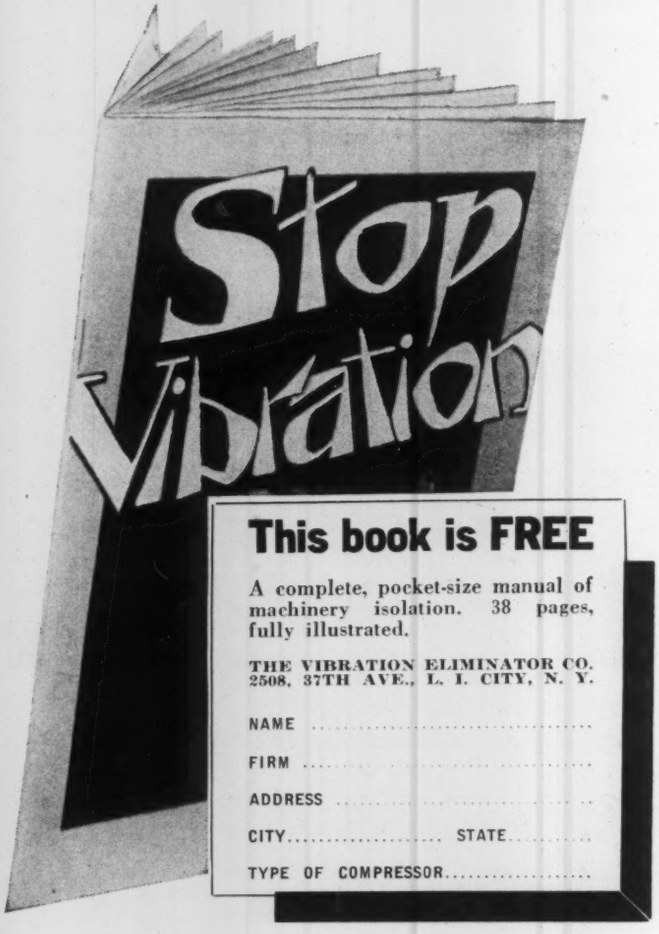

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No. 3692. GASKETS: Goetze Gasket & Packing Co., Inc., 60 Allen Ave., New Brunswick, N. J. 64 p. handbook and catalog (53) on industrial gaskets, giving engineering data developed in the manufacturer's laboratory, covering many new and improved products and with complete size and price information.

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No. 3694. INSTRUMENTS: Bristol Co., Waterbury, Conn. Mailing piece featuring the manufacturer's 50th anniversary products and services, illustrating and describing an extensive line of instruments.

No. 3695. INSULATED PIPE UNITS: Ric-wiL Co., 1563 Union Commerce Bldg., Cleveland, Ohio. 8 p. bulletin (4013) illustrating and describing insulated pipe units for underground or overhead steam lines which are factory assembled and pre-sealed. Details of supports are shown.

No. 3696. LEVEL AND PRESSURE REGULATORS: Schade Valve Mfg. Co., 2527 N. Bodine St., Philadelphia, Pa. Looseleaf catalog (6) featuring a wide range of equipment for controlling liquids, vapors and gases by variations of pressure and level. Complete data on and drawings of the various valves are presented.

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No. 3699. ODOR ADSORBERS: W. B. Connor Engineering Corp., Dorex Div., 114 E. 32nd St., New York, N. Y. 8 p. bulletin on "Dorex" odor adsorbers for air conditioning and industrial odor control, and leaflets on adsorbers for ventilating and air conditioning systems, for compressed air lines, and a self-contained circulating unit.

No. 3700. PUMPS: Peerless Pump Div., Food Machinery Corp., 1250 Camden Ave., S. W., Canton, Ohio. 4 p. bulletin on "Hi-Lift" pumps of new design, illustrating and describing construction features and explaining the operating principle.

No. 3701. SOLENOID VALVES: Automatic Switch Co., 41 E. 11th St., New York, N. Y. 8 p. circular (100) on "ASCO" solenoid valves for automatic and remote control of air, steam, liquids and gases. Various types are described.

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No. 3703. STEAM TRAPS: V. D. Anderson Co., 1949 W. 96th St., Cleveland, Ohio. 40 p. book on how to choose a steam trap, with sections on trapping unit heaters, pipe coils and heating surfaces in still air, fan system heating surfaces, steam jacketed kettles, autoclaves, submerged surfaces, hospital, kitchen and laundry equipment, steam mains and header drips, and others. General notes on trap installation, and installation, operation and maintenance instructions are included. The features of and specifications and capacities for the manufacturer's "Silvertop" traps are presented.

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FROM: Sales Manager TO: Adv. Manager

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P. J. D.

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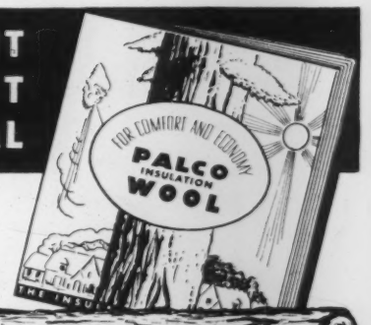

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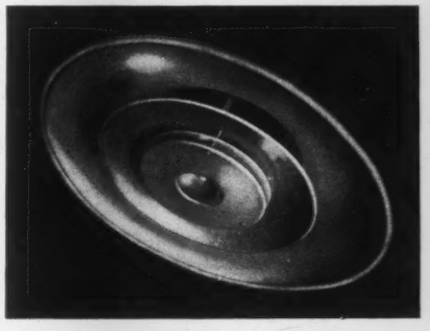

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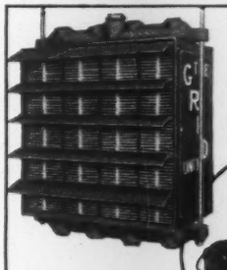

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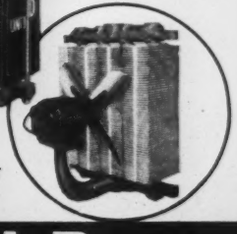

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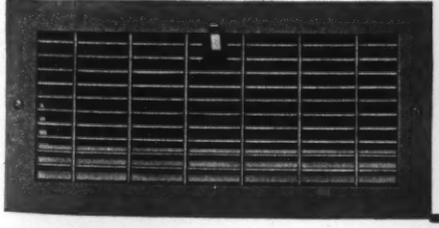

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